

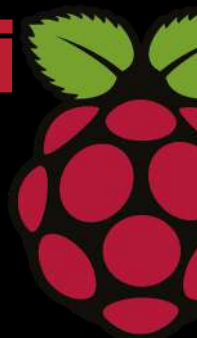
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RASPBERRY Pi

Which board is right for you?



FREE! 6 FULL PRODUCTS WORTH £131 See page 66

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**10
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HIGHLIGHTS THIS MONTH

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REVIEW OF THE MONTH

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Intel Xeon W-2500

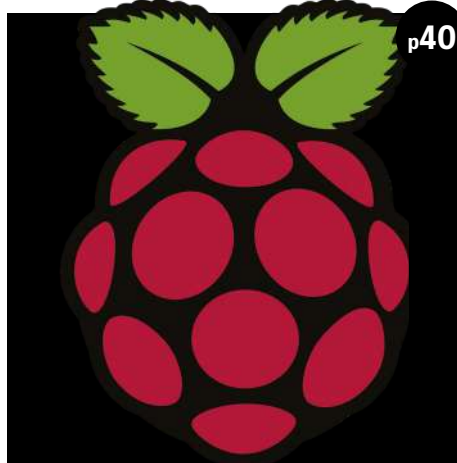
For years, AMD was the underdog when it came to top-end processors, but now it's Intel's turn to see if it can usurp its arch-rival. We put the top-end Xeon 2500 chip through its paces to see if it can outmuscle the best Threadripper and Threadripper Pro chips, which dominated our recent workstations group test. That means putting it through an exhaustive selection of tests that punish CPU cores, whether that's for video encoding, rendering or ploughing through our own tough benchmarks. Can Intel land a telling punch? Find out on p52.



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BUYER'S GUIDE OF THE YEAR

Every year, thousands of readers share their experiences of buying tech products so that we can create a unique breakdown of reliability and service. Don't buy anything until you've read it.



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BUYER'S GUIDE OF THE MONTH

The Raspberry Pi is now the best-selling computer range in the world, but to make sure you buy exactly the right model we suggest you turn to our guide on p40.



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POINTED REMARK OF THE MONTH

To get you in the mood for our group test of tablets next month, we explain how different stylus technologies work and what you need to look for when buying one.

PERSON OF THE MONTH

Alan Turing

Alan Turing's genius continues to have an impact a century after his birth, as we consider what it now means to pass the Turing test and how to measure exactly how intelligent an AI really is.



THE LABS IN ONE NUMBER

Consider this: one of the mini PCs in our group test takes up 470ml of space. That's less than a half-litre bottle of water. Yet it contains enough compute power to cover most people's needs for the next five years, possibly longer. Find out which one is right for you as we put ten to the test.





REVEALED! BRANDS YOU CAN TRUST

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RASPBERRY Pi

Which board is right for you? **p40**



FREE! 6 FULL PRODUCTS WORTH £131 **p66**

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MINI PCs

Don't think big, think small: the latest generation of mini PCs have all the power most people need while consuming surprisingly little electricity. We test ten mini marvels that can cut down on space and bills.

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Dave Mitchell explains what to look for in endpoint protection software and puts four outstanding options through their paces.



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Maths questions. Silly word puzzles. Counting the letter "r" in a sentence. Nicole Kobie reveals how we're trying to work out exactly how intelligent AI is.



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Whatever you do, don't buy our editor a smartwatch for Christmas

Sometimes I hate technology with all my might and whatever is left of my soul. If I were to crystallise this into one piercing needle of hatred, it would be directed at notifications. Meaningless, pointless, endless and always stupid notifications.

And if there's one device that epitomises this most detestable of modern scourges, it's the smartwatch. Because every single smartwatch in the world – and there is no grey here – is making our lives worse. Not only your life; my life too. When I go out for a drink with a friend, there's nothing worse than them glancing down at their wrist mid-sentence to check a notification on their watch. They pause the sentence, realise the message isn't important, and then attempt to pick up the thread.

But I've got incredible news. That notification isn't important. It's never important. If it's important, someone will call you.

You see, you're not important. I'm not important. We don't run the country. Nobody is staring at

Outlook in Whitehall waiting for your reply to an email. If you stop to think about it for even a moment, there are incredibly few things in our lives that require such urgent attention that we actually have to deal with them right here, right now.

The trouble is that in our headlong rush to embrace new technology, and our equally addictive need to feel like we matter, we've stopped distinguishing between urgent and everything else. And 99.99999% of the time, the messages that flit onto our watches and disturb perfectly good conversations about what the name of that actress was who played whatsit in that series about thingamabobs aren't urgent.

"But I need my watch for fitness," I hear you cry. No, you don't. Unless you're an Olympic-level athlete trying to shave a fraction of a second off your PB, you can measure your time, distance and speed perfectly well with a smartphone. And ask yourself this: do you really need to measure it at all? Aren't the best runs, swims and bike rides when we don't check our data every five minutes?

If you're even thinking about making the argument that smartwatches are a valuable asset in our battle against obesity, please explain to me why Western countries – the same countries where such watches are most popular – are all suffering from growing levels of obesity?

It isn't smartwatches alone, but each blinking – literally and figuratively – device we own. Sometimes it feels like every sodding time I load an app on my phone it asks me if I want to activate notifications. No, I don't, BBC Sport, because the stunning news that England has a new manager of its men's football team is one of those events I can digest at leisure. This is why I deactivated notifications in the first place. Leave. Me. Alone.

I realise I sound like I've lost it, but it's too much. Someone has to take a stand. And if it isn't the editor of a technology magazine, who else is it to be?

Tim Danton
Editor-in-chief

CONTRIBUTORS



Tim Danton

When I started writing the column above I fully intended to mention the distraction-preventing TCL 50 Pro Nxtpaper 5G, but I got distracted myself. Read my review on [p74](#).



Olivia Whitcroft

Our time-travelling legal expert revisits 1999 to get a longer perspective on data protection issues, before bringing us bang up to date. See [p116](#).



Rois Ni Thuama

Together with Barry Collins, Rois investigates the claims made against Darktrace now that one of its most senior figures has joined the UK government. Read all about it on [p12](#).



Jon Honeyball

Not for the first time, Jon is worried about Microsoft – and in particular whether the latest product recall means that it's going to abandon Windows on Arm yet again. See [p130](#).

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To tie in with our mini PC Labs, we wondered: what is the smallest device with a CPU inside that you've ever bought?

"Now that I've abandoned smartwatches – I may have mentioned this in my column on p7 – and I don't use earbuds, I think the boring answer must be my phone. But if someone wants to buy me a smart ring for Christmas, you know where I am."

"I'm sure my Snark guitar tuner must have a signal processor SoC in it... if not, my earbuds include some CPU capability to do noise reduction and voice processing."

"Either a pocket-sized electronic game back in the 1980s, or my current smartwatch. (Needless to say, the battery life was better on the former.)"

"A Tiny computer. (Little joke for the older readers in the house there, and no, I didn't really buy one.)"

"I guess it would be a Fitbit Charge 4. Terribly out of date now but then I'm hardly Daley Thompson."

"8-way USB supercharger. It scans across the connected devices and shows the current draw for each one on a wee LCD display. Whatever's in there must be awfully bored by now."

"The Pinecil V2 soldering iron. It uses a 32-bit RV32IMAFC RISC-V SiFive E24 Core to run ironOS... apparently."

"My continuous glucose monitoring device, which I not only own but is now actually part of my body."

"Oura ring. Does that count? It's in a drawer with a lot of dumb purchase smart things..."

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Briefing

Background and analysis on all the important news stories

Cracks appear in the walled gardens

Authorities on both sides of the Atlantic are chipping away at Android and iOS



Five years ago, it would have been hard to imagine that the maker of *Fortnite* would become the biggest threat to Apple and Google. But a series of court and regulator victories in both the EU and the US means Epic Games is now arguably the most potent risk to the business model of the mobile duopoly.

In the EU, Apple has already been forced to offer third-party app stores on iOS – albeit in the most grudging, inconvenient way possible – and allow app makers to use their own payment systems. Now a Californian judge has ruled that Google must do likewise with Android, among a host of new conditions placed on the company. Google is, naturally, appealing.

There's even talk of the US Department of Justice seeking to break up Google, in an echo of the proceedings brought against Microsoft 25 years ago. The question now is whether the cracks appearing in Google and Apple's walled gardens will turn into anything more structural.

Epic Games made its name for a battle royale game in which you must fight odds of 100/1 to become the last player standing. Few would have given it even those odds of success

when taking on both Apple and Google in protracted legal battles, but Epic certainly appears to have gained the upper hand so far.

Epic's latest victory came in the Northern District of California, where Google was found to have violated the Californian Unfair Competition Law. An injunction issued by District Judge James Donato ordered that Google must not prohibit the distribution of third-party app stores through the Google Play Store – a change from the current system where Android users can install third-party stores by direct download, but only after diving into settings and accepting ominous-sounding security warnings.

Furthermore, Google must not stop developers from telling customers about cheaper ways to buy apps or in-app purchases outside of the Play Store; and must not prevent the use of in-app payments other than Google Play Billing.

All of these conditions, plus several others, will last for three years,

ABOVE Both Google and Apple are facing legal challenges to their dominance

“We only need look to the EU to see what little impact the arrival of third-party app stores on iOS has made”

although they're only effective in the US. Google plans to appeal, in the same way Apple did successfully when it lost a similar court battle with Epic, but Epic remains bullish. “The Epic Games Store and other app stores are coming to the Google Play Store in 2025 in the USA – without Google's scare screens and Google's 30% app tax – thanks to victory in *Epic v Google*,” Epic CEO Tim Sweeney tweeted.

■ Hollow victory?

Even if Google loses its appeal, Epic's victory may be a hollow one. We only need look to the EU to see what little impact the arrival of third-party app stores on iOS has made in that market.

Although it means that Epic Games can once again distribute *Fortnite* on iPhones in the EU, having been kicked out of the App Store for trying to implement its own in-app payment system, there are few signs of others trying to compete with the Apple.

That's partly because Apple still applies a battery of fees for apps that avoid Apple's own store or payment systems. There's a commission fee of 10% for purchases made via third-party payment systems, a 5% initial service fee that applies to “all sales of digital

goods and services, the customer makes on any platform, that occur within a 12-month period after an initial install", not to mention a "core technology fee" of €0.50 for each first annual install over 1 million installs. That on top of a raft of new revenue reporting and compliance procedures.

These fees are facing yet more legal challenges in the EU, with Sweeney arguing that "Apple continues its malicious compliance by imposing an illegal new 15% junk fee on users migrating to competing stores".

Even if rival app stores do emerge, analysts think there's little chance of consumers actively seeking them out. "How many people do you know complaining how expensive it is to buy apps on any app store?" asked Francisco Jeronimo, vice-president of devices at IDC. "No-one really cares, because either they can afford it or they can't, and the experience overall is good across all platforms."

Paolo Pescatore, founder of PP Foresight, says there are other reasons why consumers won't rush to rival app stores. "Opening up a platform and letting other developers use their own systems will be fraught with security and privacy concerns," he said. "More so considering the growing cybersecurity attacks," he added, saying it "is another hurdle for users to overcome".

“Even if rival app stores do emerge, analysts think there's little chance of consumers actively seeking them out”

■ Breaking up

The bigger problem for Google may be the growing threat of a break-up. US Department of Justice officials are once again floating the idea of splitting the company, with search and Android divisions forcibly separated. It's a similar remedy to the one proposed by the DoJ in the late 1990s, when it wanted to separate Windows from the rest of Microsoft, and we all know how that ended after endless rounds of legal appeals.

"I don't think Google Play will be the massive challenge [for Google]," said Jeronimo. "I think the biggest challenge is on the search engine... and the advertisement business."

Jeronimo said that Google will "definitely have to come to some sort of agreement" with regulators, both in the US and the EU. "They will have to either break the business or find some remedies that will please the regulators. Apple is doing it already with the App Store in Europe."

One thing remains certain: all of this will take years to work through the courts. The walled gardens will be standing for some time to come, even if they are beginning to crumble.

Get ready for 6G... by 2030

Industry to gear up for next-generation mobile standard

Still struggling to get even a faint whiff of a 5G signal? Well, you might be saying the same about 6G in as little as five years' time.

CCS Insight's annual round of technology predictions makes several educated guesses about developments in 6G. The firm estimates that lead operators will be ready to roll out 6G in 2030, and that it will be a cleaner, less complex rollout than the mish-mash of standards that the "damaging" 5G rollout has delivered.

The company also predicts that, despite calls for regional standards, there will be a single global 6G standard. Not that operators will wait for that standard to be settled before they start using the term in their marketing. CCS forecasts that at least one operator will start using empty phrases such as "6G-ready" or "6G-like performance" in 2026 – and be widely panned for doing so.

What can we expect from 6G? "The research and development's already happening," said Ian Fogg, research director at CCS Insight. "Spectrum is being allocated, the industry is moving ahead with it. You need the new spectrum, you need the new capacity, because data usage continues to rise."

BELOW 6G is on the way – but 5G technology should also improve as 2G and 3G are switched off

"We expect it [6G] to arrive around 2030, so around a ten-year cycle," Fogg added. "Operators will then choose whether they decide to deploy it."

■ 5G boosts

In the meantime, there are a couple of further boosts to 5G that could pave the way to the new standard. Standalone 5G – equipment that's built purely on a 5G core network and doesn't rely on old 4G infrastructure – is already rolling out. And then there's 5G Advanced, which promises improved energy efficiency and enhanced coverage, which is due to arrive in the next year or two.

Fogg describes 5G Advanced as "version two of 5G" that he hopes will "overcome the negativity on 5G" that consumers have experienced since the early rollouts at the turn of the decade.

"This second wave of 5G is really important," said Fogg. "It sets the foundation for 6G."

5G will also improve after the 2G/3G switch-off, which is currently in progress. "You'll see benefits coming through as 2G and 3G are switched off in different countries and that spectrum gets used for modern technology," said Fogg. "You can support either more users or more data traffic in the same amount of spectrum. So that will actually cause a measurable improvement in 5G before 6G arrives."



The Darktrace leading to government

British security firm Darktrace has been mired in controversy. Now its former CEO is a government minister. **Rois Ni Thuama** and **Barry Collins** investigate

When the American software investment firm Thoma Bravo completed a whopping \$5.3 billion takeover of Cambridge-based security firm Darktrace in October, it raised a few eyebrows.

Darktrace – co-founded by the entrepreneur Mike Lynch, who died when his yacht sank in a storm off the coast of Sicily in August – was accused of financial irregularities, similar to those that dogged Lynch's Autonomy. Booking hardware sales as software and using resellers to inflate sales figures were only two of the allegations levelled at Darktrace (tinyurl.com/363darktrace), all of which the company denied.

Then its CEO resigned in the middle of the takeover talks, only to become Keir Starmer's new investment minister a few weeks later.

Thoma Bravo will now take the company private, perhaps hoping to take Darktrace out of the spotlight. But many questions hang over the security firm.

■ Out of Autonomy

Darktrace was trumpeting the miraculous powers of artificial intelligence long before the current AI bubble. Established in Cambridge in 2013, the company claimed to have "pioneered a proactive, AI-native approach to security" that "defends against unknown threats using AI that learns from your business in real-time".

The company was set up by Invoke Capital, a venture capital fund founded by Mike Lynch, using some of the proceeds from Autonomy's \$11.7 billion sale to Hewlett-Packard two years earlier.

Lynch wasn't the only link between Autonomy and Darktrace. Many of Darktrace's senior management had previously worked for Autonomy (see box below), including the former CEO Poppy Gustafsson (now a government minister), chief

technology officer Jack Stockdale, and chief strategy officer Nicole Eagan. In all, around 40 employees migrated from Autonomy to Darktrace, according to research conducted by investment fund ShadowFall (tinyurl.com/363shadowfall).

“Booking hardware sales as software and using resellers to inflate sales figures were only two of the allegations levelled at Darktrace”

Darktrace's top table and its links to Autonomy

The links between Autonomy and Darktrace were manifold, with dozens of Autonomy staff going on to work for the security firm, including several senior executives. Poppy Gustafsson, CEO of Darktrace until September and described as one of the company's co-founders, was previously a corporate controller at Autonomy. While there's no suggestion Gustafsson was involved in any criminal activity, court documents reveal she was involved in Autonomy's financial dealings.

For example, one of the accusations levelled at Autonomy by HP was that a Q3 2009 earnings call "amounted to a pack of lies", with HP specifically questioning the amounts that Autonomy had claimed to invest in R&D (tinyurl.com/363judgment).

When cross-examined during the 2022 civil case brought by HP, Gustafsson told the court that a \$2.5 million R&D figure attributed to a

product called SPE (Structured Probabilistic Engine) was based on a "sort of qualitative context around the development of SPE that you can't do in a spreadsheet".

The judge later ruled that "the Q3 2009 earnings call so far as it related to SPE contained a series of falsehoods with the objective of concealing the hardware sales and costs".

A spokesperson at the Department for Business and Trade told *PC Pro*: "The Minister is not, and has never been, the subject of these legal proceedings and there is no implication of wrongdoing on her part. She has been called to give evidence as a witness in this case, which relates to matters that occurred over the course of her extensive private sector career 15 years ago."



Other former Autonomy employees occupied very senior roles at Darktrace. Jack Stockdale, the Darktrace CTO, was a technical director at

Autonomy and then went on to serve as chief architect at Invoke Capital, Lynch's venture capital fund

which set up Darktrace.

Nicole Eagan, Darktrace's chief strategy officer and AI officer, was chief marketing officer at Autonomy at the time it was sold to HP.

She was described by Justice Hildyard as one of Lynch's "loyal lieutenants", who "would not have done anything of which they thought he might disapprove".

Again, there's no suggestion that Eagan was part of any criminal activity.

Other senior Darktrace executives who held senior roles at Autonomy include John Allen (Darktrace's vice president of cyber risk & compliance), Eloy Avila (chief technology officer for the Americas) and Jeff Cornelius (executive vice president for cyber-physical security).



■ The Darktrace accusations

Despite its strong bonds with Autonomy, Darktrace had avoided being dragged into controversy. That was until early 2023, when it faced a barrage of accusations from a firm called Quintessential Capital Management, a New York-based asset management company.

Before we dive into the allegations, it's worth pointing out that Quintessential Capital Management, like ShadowFall, are short sellers. They profit when companies they invest in see their stock price slide. Quintessential made a series of detailed and specific allegations against Darktrace, some with distinct echoes of the kind of malpractice for which the Autonomy executives were found guilty.

Gustafsson has frequently been labelled as Lynch's protégé. Indeed, when she and Stockdale were awarded OBEs in the 2019 Birthday Honours List in recognition of their services to cybersecurity, Gustafsson paid tribute to Lynch in a Darktrace press release, thanking him for his "support and mentorship".

■ Lynch's troubles

By the time of Gustafsson's tribute to Lynch in 2019, he and Autonomy were many years into the financial scandals that dogged the entrepreneur until his death this summer. Little more than a year after the 2011 takeover, HP announced it was taking an \$8.8 billion accounting charge on its purchase of Autonomy – three-quarters of the initial purchase price – because of "serious accounting improprieties" at Autonomy.

There followed many years of investigations and court cases on both sides of the Atlantic, culminating in Lynch's acquittal in San Francisco earlier this year, when he faced several criminal charges of fraud for inflating the value of Autonomy ahead of its sale to HP. Although Lynch was vindicated on that occasion, Autonomy and its executives did not always have success in the courts.

In January 2022, HP won a UK civil case against Lynch and the company's former chief financial officer Sushovan Hussain, who were found to have defrauded HP by manipulating the company's accounts to boost its value. In his summary (tinyurl.com/363judgment), Justice Hildyard ruled that a hardware selling scheme conceived "in order to enable Autonomy to cover shortfalls in software revenue" was "dishonest" and that "the defendants were well aware of this".

Hussain was also found guilty of a conspiracy to commit wire fraud in a US federal court in 2018 and was subsequently sentenced to five years in prison.

ABOVE Darktrace's former CEO is now a minister in the new government

Quintessential said it had "detected a pattern of transactions suggesting that a portion of Darktrace's past recurring software sales may instead be one-off sales of hardware appliances" (tinyurl.com/363darktrace). It further accused the company of using "marketing activities to channel funds back to its partners as payment

“Gustafsson was welcomed by Keir Starmer as ‘an accomplished entrepreneur who brings invaluable experience to the role’”

for apparently fictitious purchases" and of "front loading existing contracts" – in other words, making long-term sales look more valuable than they really are by taking more money from clients at the start of a contract than towards the end.

Thoma Bravo, Darktrace's new owners, didn't reply to

PC Pro's request for comment.

Did you work with Darktrace?

Has your company had dealings with Darktrace? Have you used the firm's products? Have you worked for the company itself? We'd like to hear your experiences of Darktrace – good or bad. Please send an email to barry@mediabc.co.uk with any observations.

■ Secure future

What the future holds for Darktrace awaits to be seen. A statement put out by Thoma Bravo when the takeover was announced suggested it wasn't about to bury the brand or fold it into one of the other security firms in its portfolio, including Sophos and Barracuda. "Our ambition is to help the business scale to be a truly global player, expanding the team's innovative pipeline of development opportunities and capabilities for its customers," said Seth Boro, managing partner at Thoma Bravo.

As for Poppy Gustafsson, she had just shy of four million ordinary Darktrace shares in her portfolio when Thoma Bravo announced its intention to buy the company in April, and has her new job as the government's investment minister to be getting on with. She was welcomed by Keir Starmer as "an accomplished entrepreneur who brings invaluable experience to the role".



5 things we learned from Lenovo Tech World '24

In a landmark event where the CEOs of AMD, Intel and Nvidia all took to the stage, the theme of “smarter AI for all” was never far away, writes **Tim Danton**

Lenovo uses its annual Tech World event to showcase its latest technologies, but don't imagine laptops or PCs. This year in Seattle, its theme was “Smarter AI for all”, and while we saw the debut of one new ThinkPad (see “Hard news”) there was far more talk about AI in the cloud. And partnerships. Which is why the first thing we learned was perhaps the most bizarre: AMD and Intel are working together.

1. x86 ain't dead yet

AMD and Intel announced they were going into partnership at Tech World. Well, almost. The companies simultaneously posted about the all-new “x86 Ecosystem Advisory Group” at the same time that Intel CEO Pat Gelsinger took to the stage. “Some have said, well, you know, is the x86 done?” he said. “Well, I'll tell you, rumours of my death are severely exaggerated. We are alive and well, and the x86 is thriving.”

The two silicon giants are joined by big hitters such as Dell, Google, HP, Lenovo and Meta, along with Tim Sweeney, founder and CEO of Epic Games, and Linus Torvalds.

“The advisory group brings together leaders from across the ecosystem to shape the future of the x86 to simplify software development,” said Gelsinger, “to ensure interoperability and interface consistency, to provide developers with standard architecture tools, instruction sets, to have a clear view of the future.”

But it wasn't a defensive move against Arm and Apple, he insisted, but about expansion. “We think of it as one of the most significant periods of innovation in front of us, and we see that the x86 architecture, this foundation of computing for decades, is about to go through a period of customisation, expansion, scalability,” he argued, declaring that AI would present many opportunities to keep the x86 ecosystem “robust and growing”.

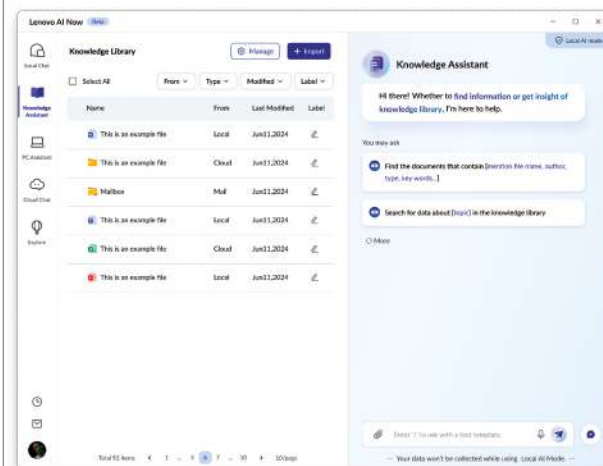
Dr Lisa Su, AMD's chair and CEO, was equally enthusiastic, saying that “x86 has been the foremost leader in architecture over the last 40 years, and the idea is AMD and Intel are bringing together all of these founding members [who] can really accelerate the pace of innovation going forward”.

2. AI is getting personal

You can be as cynical as you like about AI, but it's here – and it's here to help. Or at least, that was one of the core messages from the many speakers at Tech World. This was backed up by two announcements at the show, kicking off with Lenovo AI Now.

This “AI agent” will sit on new Lenovo ThinkPads and run on the NPU, which means it stays local and private. Over time, it will become more tuned to what you do, but

BELOW Lenovo AI Now is bringing AI assistance to the ThinkPad range



box-fresh you can use it to check locally stored files for keywords, and then ask it questions, such as searching for data about a specific company you're dealing with.

In the future, Lenovo could also act as a teacher thanks to the Lenovo Learning Zone. Say you're a student at university who's attending lectures. Load up the recordings along with any notes you write, and it can distil that information into learning aids such as a quiz, or you can use it to generate flash cards.

3. Servers are cool

While local AI is improving thanks to more powerful NPUs now being built into mobile processors, for the foreseeable future there's an unquenchable demand for high-power GPU accelerators in data centres. And power is the key word, as those GPUs require huge amounts of cooling.

That's why Lenovo is doubling down on its Neptune water cooling system, which – it announced at Tech World – is now in its sixth generation. I spoke with Scott Tease, GM of AI and High-Performance Computing at Lenovo, who explained that “cool” isn't quite the right word. “Even though we're using hot water [45°C], the temperatures we're able to keep the components at are cooler than we could ever do with air cooling [at 25°C],” he said. And it's about temperature differences. When the water leaves, it carries away 20°C of heat as it's gone from 45°C to 65°C.

Lenovo's new ThinkSystem N1380 Neptune chassis will thus allow customers to run 100kW+ server racks without specialised air conditioning. And that means denser clusters of compute power that still run on the same infrastructure as before.

This was the point at which Nvidia president and CEO Jensen Huang took



ABOVE Nvidia's Jensen Huang and Lenovo's Yuanqing Yang are joining forces

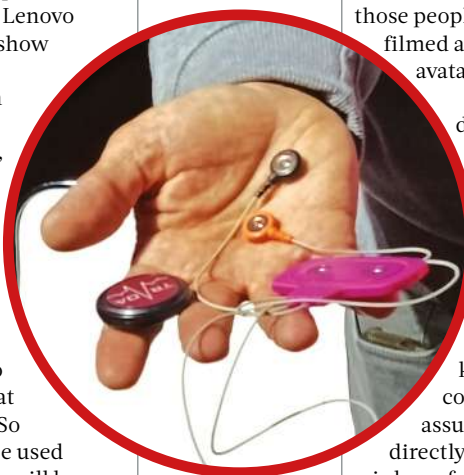
to the stage, to jointly announce with Lenovo chairman and CEO Yuanqing Yang another partnership: the Lenovo Hybrid AI Advantage with Nvidia. And in particular, the ThinkSystem SC777 V4 Neptune which will include Nvidia Blackwell and Nvidia GB200 silicon.

4. AI can save lives

Away from the glossy presentations and big-name speakers, I spoke to Hildebrando Lima, part of Lenovo Research in Brazil, on the show floor itself. In his hand, an unremarkable sensor with wires poking out in every direction – but this device, with the help of AI, may have already saved lives.

“It was detected that the window of 72 hours after hospital discharge, after surgery, is the most critical one for sudden deaths and also episodes of arrhythmia that can kill people,” he said. “So we developed a device to be used for seven to 15 days. People will be monitored 24/7 using an AI platform.”

Lenovo and the team at the Heart Institute of São Paulo then ran a pilot scheme that included



ABOVE The AI sensor that's being used to monitor patients after they leave hospital

250 people who were in the at-risk group. “We detected two people where the device informed us of the issue, and if it was not detected on time there would have been severe complications with risk of death.”

If approved by the authorities in Brazil, the technology could be rolled out as early as summer 2025.

5. AI could help with Alzheimer's

While AI can't save us from Alzheimer's – yet – Lenovo has introduced a tool that might just help. Called Alzheimer's Intelligence, it's based on two years of work with the UK-based Innovations in Dementia, where it gleaned insights from people living with dementia and their families. It then used this data to create a large language model that can be asked questions.

Rather than keep it text-based, Lenovo created a 3D avatar based on a composite of ten people who are living with Alzheimer's. It then blended those people's expressions with a filmed actor, which is why the avatar looks so realistic.

“When people are first diagnosed with dementia, they can feel lost, with so many questions about what is happening,” said Steve Milton, director of Innovations in Dementia. “This AI doesn't replace human contact but what it does do is offer a knowledgeable and compassionate source of assurance and advice based directly on the experiences and wisdom of other people with dementia.”

For now, Alzheimer's Intelligence is a proof of concept, but there are hopes that it (or an iteration) can be released to the public in the future. ●

Hard news

Lenovo Tech World isn't the place to go if you're after gadgets, but Lenovo showcased two pieces of hardware this year. The first is frankly a little bizarre: the Lenovo AI Buddy. It's a concept device – and I doubt it will be more than that – which places a circular screen on top of a Lenovo mini PC. You then ask it questions, as you would an Amazon Echo, to access information stored locally and around the world. And it has blinking, cartoon eyes.

Let's move on to something more serious, which is the ThinkPad X12-in-1 Gen 10 Aura Edition (pictured below). This 14in convertible features Intel's Core Ultra 200V processors, so expect excellent battery life, and packs the usual high-quality components you'd expect from a ThinkPad X1 machine. The system on show featured a punchy OLED panel, but IPS versions will be available, and it was pretty light at 1.3kg.

If you read our IFA coverage (see issue 362, p42) then you'll be aware that Lenovo Aura Edition devices – this 2-in-1 is the third announced Aura product – feature extra AI-based features that are meant to make your life easier, such as tapping your phone against the side of the laptop screen to activate file sharing. Lenovo expects to release the new ThinkPad in February 2025, with prices starting at \$2,199 in the US.



BELOW The bizarre Lenovo AI Buddy, complete with “friendly” cartoon eyes



The A-List



The best products on the market, as picked by our editors

PREMIUM LAPTOPS

Asus Zenbook S 14 OLED

Staggering battery life for £1,750

from scan.co.uk

Asus gives Intel's "Lunar Lake" family a debut, pairing a Core Ultra 9 288V with a 72Wh battery to produce a laptop that lasts almost 20 hours on a charge. What's more, this 1.2kg machine looks (and feels) the business.

REVIEW Issue 362, p46



BUSINESS LAPTOPS

Lenovo ThinkPad T14s Gen 6 (Snapdragon)

Copilot+ PC for £1,500 exc VAT

from lenovo.com

It's perhaps a controversial choice – and we wouldn't roll this out en masse – but if you're buying for executives or CTOs this cutting-edge Copilot+ PC, complete with a Qualcomm Snapdragon Arm processor, is a superb choice. Not only is it good value, it's light, it's fast and its all-day battery life is genuinely 24 hours.

REVIEW Issue 360, p56



Apple Mac Book Air 13in (M3)

Both the 13in and 15in MacBook Airs impress for speed, styling and battery life, but the 1.2kg 13in Air wins out of the two for its sheer portability. **From £1,299**

from apple.com

REVIEW Issue 356, p54

Apple MacBook Pro 16in (2023)

The M3 chips give the MacBook Pro series a boost in games with no sacrifices elsewhere, so you just have to grapple with the big decision: which M3 chip? **From £1,699**

from apple.com

REVIEW Issue 352, p46

Asus ProArt PX13

With AMD's new Ryzen AI 9 HX 370 inside, this 1.4kg compact powerhouse offers incredible amounts of power. Add a fantastic OLED screen and RTX 4070 graphics and it's a winner.

From £2,000

from uk.store.asus.com

REVIEW Issue 361, p50

Lenovo ThinkPad X1 Carbon Gen 12

The X1 Carbon range has stepped up a gear thanks to Intel's Core Ultra chips, and Lenovo matches it with the stunning build quality and keyboard you'd expect. **From £1,375**

from lenovo.com

REVIEW Issue 358, p58

Dell Latitude 9450 2-in-1

This 14in convertible, based around Core Ultra CPUs, lacks for nothing, whether that's speed, battery life (around 16 hours), build quality or flexibility. **From £1,560**

exc VAT from dell.co.uk

REVIEW Issue 361, p63

HP Dragonfly G4

It's not the fastest machine you can buy, but otherwise this 1kg masterpiece is as close as you're going to get to the perfect business laptop for executives.

From £1,380

exc VAT from hp.com

REVIEW Issue 352, p58

COPILOT+ PCs

Lenovo Yoga Slim 7x (Gen 9)

AI on demand, £1,350

from lenovo.com

You won't find a better-value laptop, never mind one that meets the Copilot+ PC criteria. With a Snapdragon X1E-78-100 inside it isn't the fastest in benchmarks, but it's incredibly nippy in practice, the battery lasts over 16 hours and the 14.5in OLED screen is top quality.

REVIEW Issue 361, p57



EVERYDAY LAPTOPS

Acer Aspire 14 A14-51GM

Compact power for £850

from acer.com

Want gaming power? Buy the version with RTX 2050 graphics for £850 (part code NX.KSVEK.005). Just care about value? Get a Core 5 processor and integrated graphics for £600 (part code NX.KRWEK.00B). Whichever you choose, it's a staggering laptop for the price.

REVIEW Issue 359, p82



Samsung Galaxy Book4 Edge

A classy 16in laptop that weighs 1.6kg, uses the fastest Snapdragon Elite X chip and delivers a solid 12 hours of battery life.

512GB, £1,499

from samsung.com

REVIEW Issue 360, p53

Microsoft Surface Laptop, 7th Edition

The poster child for Copilot+ PCs offers quality, great looks and staggering battery life.

From £1,049

from microsoft.com

REVIEW Issue 360, p50

Asus Zenbook S 15 OLED

With a price drop to £1,200 this 15.6in laptop becomes a viable competitor to the Yoga Slim 7x if you need a bigger screen. **£1,200**

from uk.store.asus.com

REVIEW Issue 359, p52

Asus Zenbook 14 OLED (UX3405)

If you can stretch past £1,000, this is a top-quality Core Ultra laptop with a superb 120Hz screen and great battery life. **From £1,099**

from uk.store.asus.com

REVIEW Issue 359, p58

Framework Laptop 13 (DIY Edition)

With a competitive price, modular approach and easy-to-repair ethos, you can pick and mix your perfect 13in laptop. **From £779**

from frame.work

REVIEW Issue 360, p58

Huawei MateBook D16

It's big and certainly not bashful, packing an Intel Core i9 chip and a high-quality 16in panel – and surprisingly good battery life, too. **£1,000**

from huawei.com

REVIEW Issue 359, p87

CHROMEBOOKS

Acer Chromebook Spin 714

Flipping great for £799

from [currys.co.uk](https://www.currys.co.uk)

Simply the best Chromebook around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this convertible for £799.

REVIEW Issue 356, p83



Acer Chromebook Plus 515

This Chromebook Plus laptop is all about value. With strong speeds thanks to Intel's Core i5-1235U processor, and a good-quality 15.6in panel with a 1,920 x 1,080 resolution, Asus' Chromebook Plus 515 is ideal for families, students and business users, providing mobility isn't your main priority as it isn't particularly light at 1.7kg. **£429 from [currys.co.uk](https://www.currys.co.uk)**

REVIEW Issue 356, p82

Lenovo IdeaPad 5i Gaming Chromebook Plus

The 120Hz 15.6in display is the star of this Chromebook, as it should be with 2,560 x 1,600 pixels to play with. You're getting a lot of laptop for the price, too, including a 512GB SSD, Core i5-1235U processor and 8GB of RAM. Just note the 1.9kg weight.

£659 from [very.co.uk](https://www.very.co.uk)

REVIEW Issue 356, p88

MINI PCs

NEW ENTRY

NEW ENTRY

Minisforum Venus UM790 Pro

Unrivalled bang-per-buck for £549

from [store.minisforum.uk](https://www.store.minisforum.uk)

Ignore its basic looks, for this compact system – measuring 130 x 126 x 52mm – packs in a fast AMD Ryzen 9 7940HS processor, 32GB of DDR5-5600 RAM and 1TB SSD (with space for another M.2 drive) along with a generous selection of ports, including two USB-C 4 connectors. And the £549 price is super-aggressive.

REVIEW Issue 363, p91



Geekom A8 Mini PC

Geekom makes brilliant use of AMD's Ryzen 9 8945HS in this powerful mini PC, which occupies little more desktop space than a drinks coaster. And it still packs every port most people need, plus Wi-Fi 6E. If you don't need this much power (or 32GB of RAM and a 2TB SSD) the Ryzen 7 version is £719.

Ryzen 9, £899 from [geekom.co.uk](https://www.geekom.co.uk)

REVIEW Issue 359, p62

Minisforum Neptune HX100G

Considerably larger than most mini PCs, but the cooling system extracts the most from the AMD Ryzen 7 7840HS inside. You also benefit from a powerful Radeon RX 6600M GPU, helping it average 110fps in *Shadow of the Tomb Raider* at 1080p. **£889 from [store.minisforum.uk](https://www.store.minisforum.uk)**

REVIEW Issue 363, p89

ENTHUSIAST PCs

NEW ENTRY

PCSpecialist Torpedo Ultra R

Compact RTX 4070 for £1,799

from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)

This compact PC, built around the miniITX Corsair 2000D RGB AirFlow chassis, packs in a Ryzen 7 7800X3D, GeForce RTX 4070 graphics and 2TB of fast storage. The fans are noisy, but that's the price you pay for power.

REVIEW Issue 363, p56



CyberPowerPC Infinity X145 Elite

Designed to deliver the maximum possible gaming power for £999, this Core i5-14400F system – with 32GB of DDR5 RAM and GeForce RTX 4060 graphics – is a great machine now with potential for more later. **£999 from [tinyurl.com/360cyber](https://www.tinyurl.com/360cyber)**

REVIEW Issue 360, p61

Palicomp AMD Destiny

An incredibly fast gaming PC for the money thanks to the wicked combination of AMD's Ryzen 7 7800X3D and Nvidia's GeForce RTX 4070 Super. With a fast 1TB SSD and 32GB of RAM in support, it's enough for smooth 4K gaming. **£1,249 from [palicomp.co.uk/d destiny-mag1](https://www.palicomp.co.uk/d destiny-mag1)**

REVIEW Issue 360, p60

ALL-IN-ONE PCs

HP Envy 34 All-in-One

£2,099 widescreen wonder

from [hp.com](https://www.hp.com)

Built around a high-quality 34in widescreen – which is perfect for viewing two windows side by side thanks to its 21:9 aspect ratio – this also comes with Nvidia RTX 3060 graphics. We're big fans of the magnetic 16-megapixel camera, too.

REVIEW Issue 335, p46



Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money.

From £599 from [dell.co.uk](https://www.dell.co.uk)

REVIEW Issue 350, p47

Apple iMac 24in (M3)

The iconic design remains the same, but the plain M3 chip inside the revamped iMac 24in is a revelation compared to the previous M1 version. The downside is that the base configuration includes a stingy 8GB of memory and a 256GB SSD.

From £1,399 from [apple.com](https://www.apple.com)

REVIEW Issue 352, p52

CREATIVE WORKSTATIONS

Armari Magnetar M64T7-AW1650G4

Threadripping power for £8,329 exc VAT

from [armari.com](https://www.armari.com)

AMD's Ryzen Threadripper 7980X is the star of this particular show, dominating our benchmarks with the help of 128GB of RAM, two 2TB Crucial PCI-E 5 drives in RAID0 configuration and AMD's Radeon Pro W7800 professional GPU. And it's all wrapped up in a custom Armari case with liquid cooling.

REVIEW Issue 361, p92



PCSpecialist Quantum Goliath R

Extracting maximum power from its budget by opting for consumer components with professional levels of power, this well-thought-out workstation couples Intel's Core i9-14900KS with RTX 4090 graphics to tremendous effect. **£3,750 exc VAT from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)**

REVIEW Issue 361, p89

Scan 3XS GWP A1-TR64

A more balanced offering than Armari's Magnetar, Scan mixes a Threadripper 7970X with Nvidia RTX 5000 graphics – and a stunning supporting cast of components with an equally stunning case. Perfect for real-time viewsets and GPU accelerated computation.

£7,917 exc VAT from [scan.co.uk](https://www.scan.co.uk)

REVIEW Issue 361, p94



TABLETS

Apple iPad Air (M2)

M2 power from £599
from apple.com

We love the new iPad Pro, but for most people the M2 iPad Air is not only far better value but also all the tablet they'll need. It supports the Magic Keyboard and Pencil Pro, plus it's now available in both 11in and 13in sizes.

REVIEW Issue 358, p50



Apple iPad Pro (M4)

The best tablet in the world becomes even better thanks to Apple's stunning M4 chip, a gorgeous OLED screen and the must-have accessory: the all-new Pencil Pro. But it comes with an obvious downside of cost, with the cheapest 13in incarnation costing £1,299. **From £999 (11in, 256GB) from apple.com**

REVIEW Issue 358, p48

OnePlus Pad

The OnePlus fully justified its place in our luxury tablet Labs thanks to its outstanding build quality, slick performance and stunning 17-hour battery life. It's the best Android option outside of Samsung's Galaxy Tabs – and it won't do nearly so much damage to your wallet.

£449 from oneplus.com
REVIEW Issue 352, p86

EVERYDAY PHONES

Motorola Moto G54 5G

Great looker for £180
from johnlewis.com

The 6.5in 120Hz IPS display is the G54's standout feature, but it improves on the previous generation in numerous ways while being even cheaper. It's faster, looks better, takes great photos and battery life is strong. You won't find better for less than £200.

REVIEW Issue 355, p77



Google Pixel 8a

We're fans of the Pixel 8 but you can save £200 and buy the 8a without missing out on any key features, including its advanced AI skills thanks to the same Tensor G3 chip inside. It's only when you zoom into snaps that you spot the camera quality difference.

128GB, £499 from store.google.com
REVIEW Issue 358, p74

Samsung Galaxy A55

Not the fastest phone on the market, but in return you get a high-quality 6.6in OLED display, excellent battery life and a trio of strong cameras. And you also get four years of feature updates. With a price that significantly undercuts the Pixel 8a, it's great value, too.

128GB, £364 from johnlewis.com
REVIEW Issue 358, p77

PREMIUM PHONES

NEW ENTRY

Apple iPhone 16 Pro

Class and quality from £999
from apple.com/uk

Even without Apple Intelligence, the introduction of a 5x optical zoom, classy 6.3in OLED panel and Apple's ludicrously fast A18 Pro chipset make this the best update to an iPhone Pro for years. The improved battery life is merely the cherry on top.

REVIEW Issue 363, p70



Honor Magic V3

With the Magic V3, not only does Honor make foldable phones as slim as flagship phones but also as affordable – so long as the £300 discount voucher still applies, as shown in the price here. What's more, the cameras and both OLED panels are superb.

£1,400 after discount from honor.com
REVIEW Issue 362, p62

Motorola Razr 50 Ultra

Not merely a huge upgrade over last year's Razr 40 Ultra, this new model also leapfrogs over Samsung's new Flip6 to become our flip phone of choice. That's thanks to its great battery life, superb screens (particularly on the outside) and a camera that's a joy to use.

£1,000 from motorola.co.uk
REVIEW Issue 360, p68

EVERYDAY MONITORS

Iiyama ProLite XUB3293UHSN-B5

32in 4K bargain, £429
from currys.co.uk

The fact that this 31.5in IPS monitor could compete so well against Eizo's alternative (see below) says it all. Great colour coverage in sRGB and DCI-P3, USB-C and RJ45 inputs, plus solid build quality add up to a bargain.

REVIEW Issue 357, p88



AOC Q27B3CF2

AOC's relentless focus on value delivers a 27in 1440p screen with a high-quality IPS panel that costs £200 including VAT – and also packs in a USB-C port. Those are almost the only features you get, and the OSD is awful, but at this price we're not complaining.

£200 from amazon.co.uk
REVIEW Issue 360, p77

Acer Verso B277 Ebmiprxxv

This is a basic but high-quality monitor, delivering colourful images across its 27in Full HD diagonal. You don't get USB-C docking, but it includes VGA, HDMI and DisplayPort inputs, plus a two-port USB hub.

£149 from tinyurl.com/357acer277
REVIEW Issue 357, p84

PROFESSIONAL MONITORS

Eizo FlexScan EV3240X

Stunning 4K quality, £1,206
exc VAT from photospecialist.co.uk

With images that whack you between the eyes as soon as you lift it, fully assembled, from its box, this 32in 4K monitor is our top choice pick for anyone willing to make such a hefty long-term investment.

REVIEW Issue 357, p91



Eizo ColorEdge CG2700X

A brilliant choice for professional designers, whether working solo or in teams, thanks to its dedication to providing accurate colours across potentially years of life. It's also bang up to date for connectivity, with USB-C and RJ45 making it easy to manage, too.

£2,149 exc VAT from wexphotovideo.com
REVIEW Issue 357, p90

BenQ PD2706U

If you can't stretch to Eizo budget levels then this 4K 27in screen is definitely worth investigating. It has several features aimed at professionals, including a Hotkey Puck to switch between profiles, plus great coverage of the sRGB and DCI-P3 gamuts.

£333 exc VAT from scan.co.uk
REVIEW Issue 357, p86

WEBCAMS

Logitech MX Brio 705 for Business

Consistent brilliance for £219

from [logitech.com](https://www.logitech.com)

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.

REVIEW Issue 356, p68

Logitech Brio 105 for Business

While you can buy 1080p webcams for a third of the Brio 105's price, they won't hold a candle to the Logitech webcam's quality – especially in low-light conditions, such as one candle. It's also easy to manage, for businesses and individuals.

£45 from [logitech.com](https://www.logitech.com)**REVIEW** Issue 360, p77

Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.

£329 from [amazon.co.uk](https://www.amazon.co.uk)**REVIEW** Issue 352, p75

HOME OFFICE PRINTERS

Epson EcoTank ET-2830

Ink tank all-in-one for £250

from [epson.co.uk](https://www.epson.co.uk)

Don't expect flashy features, but do expect fast print speeds, high-quality prints, scans and copies, plus phenomenally low running costs – even after you've exhausted the 6,000 pages' worth of bottled ink that comes with it.

REVIEW Issue 353, p85

Canon Pixma TS8750

A fantastic choice for creative users that's equally at home printing photos as it is scanning artwork. Despite its high running costs, due to its reliance on cartridges, this is a superb all-in-one. **£159 from**

[printerbase.co.uk](https://www.printerbase.co.uk)**REVIEW** Issue 353, p86

HP OfficeJet Pro 9012e

So long as your print volumes aren't huge – the running costs mount up – this is a superb all-in-one for home office usage. It's fast, robust, prints double-sided and produces strong all-round results.

£208 from [printerland.co.uk](https://www.printerland.co.uk)**REVIEW** Issue 353, p87

WORKGROUP PRINTERS

Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from [canon.co.uk](https://www.canon.co.uk)

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.

REVIEW Issue 350, p58

Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page. **£415 exc VAT from**

[printerland.co.uk](https://www.printerland.co.uk)**REVIEW** Issue 353, p84

Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies. **£238 exc VAT from**

[printerbase.co.uk](https://www.printerbase.co.uk)**REVIEW** Issue 341, p87

WIRELESS ROUTERS

Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from [amazon.co.uk](https://www.amazon.co.uk)

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.

REVIEW Issue 341, p68

Netgear Nighthawk RS700S

Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.

£800 from [netgear.com](https://www.netgear.com)**REVIEW** Issue 353, p76

Asus RT-AX59U

You can buy cheaper Wi-Fi 6 routers – such as the D-Link Eagle Pro AI R15 for £55 – but Asus' well-priced offering delivers strong performance along with lots of control and exceptional VPN support. **£125 from**

uk.store.asus.com**REVIEW** Issue 350, p57

MESH WI-FI

TP-Link Deco XE200

Clever Wi-Fi 6E for £600

from [amazon.co.uk](https://www.amazon.co.uk)

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code BOBKTDPCW8) should be enough for most premises.

REVIEW Issue 349, p65

Mercusys Halo H80X

A new subsidiary of TP-Link, Mercusys offers its parent brand's XE75 router some excellent value-for-money competition. Not as fast due to Wi-Fi 6 rather than Wi-Fi 6E, but it has all the bandwidth you need for everyday use and should deliver it stably throughout your house. There are plenty of features too. **2-pack, £161 from [ebuyer.com](https://www.ebuyer.com)**

REVIEW Issue 341, p71

Linksys Velop Pro 6E

Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house. **2-pack, £380 from [amazon.co.uk](https://www.amazon.co.uk)**

REVIEW Issue 350, p54



BUSINESS WI-FI

Zyxel WAX640S-6E Wi-Fi 6E AP, £369 exc VAT

from broadbandbuyer.com

A nicely priced tri-band wireless access point ideally suited to businesses that want to provide the full range of wireless services. It's easy to deploy, wireless performance is good and Zyxel provides top-quality cloud management services.

REVIEW Issue 353, p100



TP-Link Omada EAP783

This slim-line discus has a mighty BE19000 rating and will appeal to businesses looking to make an early transition to Wi-Fi 7. It delivers superb performance and is MLO-ready, while TP-Link's Omada cloud platform offers great remote management services.

£520 exc VAT from senetic.co.uk

REVIEW Issue 360, p103

Ruijie Reyee RG-RAP2260(E)

This competitively priced Wi-Fi 6 AP delivers business-class features and impressive performance, and the free Ruijie Cloud service offers a wide range of remote network management and monitoring tools.

£160 exc VAT from broadbandbuyer.com

REVIEW Issue 359, p103

NAS SERVERS

Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This powerful eight-bay NAS is a great choice for SMBs that want plenty of capacity, features and performance at a reasonable price. The new DSM 7.2 software has security high on its agenda, and the icing on the cake is Synology's generous five-year warranty.

REVIEW Issue 346, p101



Qnap TS-h987XU-RP

The TS-h987XU-RP is a ready-made hybrid storage solution for SMBs.

This rack-friendly package offers a great specification for the price, and Qnap's QuTS hero software scores highly for its wealth of data-protection features and business apps.

Diskless, £3,292 exc VAT from broadbandbuyer.com

REVIEW Issue 344, p96

Synology DiskStation DS1522+

Small businesses that want a high-capacity desktop NAS at a good price will find Synology's DS1522+ a great choice. Performance over 10GbE is impeccable and the DSM software offers a fantastic range of storage features.

5-bay NAS, diskless £586 exc VAT from broadbandbuyer.com

REVIEW Issue 344, p98

VIDEOCONFERENCING

Owl Labs Meeting Owl 4+ Magical meetings, £1,665 exc VAT

from owllabs.co.uk

For fully immersive meetings, nobody does it better than Owl Labs. The Owl 4+ sports a new 64MP fish-eye camera that boosts video output to 4K Ultra HD while keeping super-smooth speaker tracking. Pairing it with an Owl Bar covers every meeting room angle.

REVIEW Issue 360, p102



Poly Studio X52 with TC10

Ideal for businesses that want a professional videoconferencing solution for medium-sized meeting rooms. Video quality is excellent, speaker tracking is exceptionally fast, and the big choice of built-in VC apps makes it incredibly versatile too.

£3,161 exc VAT from meetingstore.co.uk

REVIEW Issue 353, p102

Jabra PanaCast 50

This sleek cylinder delivers great video and audio quality, fast speaker tracking and a wealth of advanced features. Jabra's Xpress web portal offers smart remote management services, and the super-wide view helps make the PanaCast 50 ideal for all-inclusive meetings.

£867 exc VAT from uk.insight.com

REVIEW Issue 354, p100

SCANNERS

Xerox N60w Pro Scanner

Speed demon, £766 exc VAT

from tradescanners.com

The N60w Pro offers tremendous value and versatility. It delivered up to 67ppm in our tests with great output quality, offers a plethora of connection options and makes walk-up scanning a breeze.

REVIEW Issue 358, p101



Brother ADS-4500W

Ideal for small businesses, the ADS-4500W offers a fine set of walk-up scan features and its output quality is beyond reproach, while Brother's Print&Scan app delivers great scan workflow management options.

£295 exc VAT from printerbase.co.uk

REVIEW Issue 358, p98

Epson WorkForce ES-C320W

A space-saving wireless desktop scanner, the Epson WorkForce ES-C320W delivers nippy speeds – around 31ppm in our tests – and is backed with software that offers plenty of scan management features.

£180 exc VAT from printerland.co.uk

REVIEW Issue 358, p100

SERVERS

Dell EMC PowerEdge T350

Xeon E-2300 power, from £1,399 exc VAT

from dell.com

Perfect for SMBs and branch offices looking for an affordable and powerful single-socket tower server. Along with support for Xeon E-2300 CPUs and lots of memory, it has a high storage capacity, plenty of expansion space and is sturdily built.

REVIEW Issue 335, p98



Dell EMC PowerEdge R250

With prices starting at around £850 exc VAT for a Pentium Gold CPU, and the option of Xeon E-2300 series chips from £1,461 exc VAT, this is a slim, rack-mounted alternative to the more high-powered T350 that's ideal for SMBs.

From £845 exc VAT from dell.com

REVIEW Issue 332, p98

Broadberry CyberServe Xeon E-RS100-E10

This represents a powerful hardware package at a price that will please small businesses. We love its low-profile chassis and the fine selection of remote-management tools. It's a great alternative to the Dell EMC servers also listed here.

£983 exc VAT from broadberry.co.uk

REVIEW Issue 318, p96

SECURITY SOFTWARE

Avast Ultimate

Buy from retail and this is a bargain, with a solid VPN, anti-tracking software and handy detection fees on top of excellent protection. **10 devices, 2yrs, £30 from store.pcpco.co.uk**
REVIEW Issue 355, p84



G Data Total Protection

G Data provides straightforward, effective and inexpensive protection against malware and other threats to your system, making it a favourite despite its quirks. **5 devices, \$82 from gdatasoftware.co.uk**
REVIEW Issue 355, p87

Avast One Essential

Avast One Essential has the same malware-detection engine as our top choice, but for free. It even includes 5GB of VPN services per month and a few system optimisation tools. **Free from avast.com**
REVIEW Issue 355, p89

VPNs

Surfshark

Reliably fast and goes out of its way to ensure that international streaming services work. Surfshark has a credible track record for privacy, too. **£55 for 27 months from surfshark.com**
REVIEW Issue 360, p87



Surfshark

NordVPN

One of the best all-purpose consumer VPN services around, and the paid-for version is packed with features – from anti-malware tools to a rather clever mesh file-transfer system. **£94 for 27 months from nordvpn.com**
REVIEW Issue 360, p85

Proton VPN

A great VPN in its own right, but also the best free VPN service as you get unlimited data. Instead, Proton restricts which endpoints you can access to only three countries: the USA, the Netherlands and Japan. **Free from protonvpn.com**
REVIEW Issue 360, p86

PASSWORD MANAGERS

NordPass

This hassle-free option is a great choice for both personal and business use, with a competitive price matched with all the features most people need. **£1.89 per month from nordpass.com**
REVIEW Issue 350, p70



NordPass

Bitwarden

Free for individual use and open source, the only important thing Bitwarden lacks is phone support: it works with virtually every device and browser, and the paid option is well worth £10 per year. **Free from bitwarden.com**
REVIEW Issue 350, p71

Keeper

A great choice for businesses thanks to its focus on security and a zero-knowledge policy, and if you need more options then Keeper has them. **Business edition, from £2 per user per month from keepersecurity.com**
REVIEW Issue 350, p72

ON-PREMISES BACKUP

Nakivo Backup & Replication 10.11.2

Perfect for SMBs that want the freedom to choose their host system. It supports an incredible range of hardware platforms and OSes and is packed with data protection features. **Enterprise, 10 servers, perpetual licence, £1,118 exc VAT from nakivo.com**
REVIEW Issue 362, p100



CLOUD BACKUP

IDrive Business

A top cloud backup choice for SMBs that want to protect on-premises systems and remote workers. Platform and business app support is outstanding, it's easy to use and the simple capacity-based subscriptions are incredibly good value. **5TB, £838 exc VAT per year from idrive.com**
REVIEW Issue 359, p101



VOIP SERVICES

3CX Phone System V20

Our top choice for businesses that want to manage their own VoIP system. It can be hosted in the cloud or on-premises, and has lots of new features. **Small Business, 10 users, £175 exc VAT per year from 3cx.com**
REVIEW Issue 357, p98



Veritas Backup Exec 23

Backup Exec 23 is easy to manage, provides valuable ransomware protection and the subscriptions are great value. **Simple Core Pack, 5 instances, £498 exc VAT per year from uk.insight.com**
REVIEW Issue 362, p101

Acronis Cyber Protect 16 Advanced

Flexible subscriptions keep costs under control, the EDR service stays one step ahead of cybercriminals and it's easy to manage, too. **From £95 exc VAT per year from acronis.com**
REVIEW Issue 359, p98

TelephoneSystems.Cloud

A great choice for businesses that know what they want from cloud-hosted VoIP services, offering a wealth of features at a competitive price. **From £11 exc VAT per user per month from telephonesystems.cloud**
REVIEW Issue 357, p100

ENDPOINT PROTECTION

NEW ENTRY

WithSecure Elements Endpoint Security

A comprehensive set of protection measures for a great price, easily managed from a cloud portal. It supports a wide range of devices and the Luminen tool delivers AI-powered reporting services that present detailed summaries of events with a click. **100-499 devices, £37 exc VAT each per year from withsecure.com**
REVIEW Issue 363, p101



REMOTE SUPPORT

NetSupport Manager 14.1

Sets the standard for on-premises hosted support for local and remote workers. It delivers a remarkable range of features and its one-time cost per seat will appeal to businesses concerned about subscription fees. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**
REVIEW Issue 361, p100



SECURITY APPLIANCES

DrayTek Vigor 2927Lax-5G

SMBs and remote offices that demand always-on internet access will love this affordable security router. It offers an unbeatable set of WAN redundancy features and adds extra value thanks to its built-in Wi-Fi 6 services. **£667 exc VAT from broadbandbuyer.com**
REVIEW Issue 360, p98



Sophos Intercept X Advanced

An unbeatable range of tough security measures. Deployment is a breeze, and a multitude of security policies make it highly flexible. **100-199 users, £48 exc VAT each per year from enterpriseav.co.uk**
REVIEW Issue 363, p98

NEW ENTRY

ISL Online Standard

Perfect for SMBs wanting cloud-based support. Features and access security are excellent, as are its flexible licensing plans. **Standard Cloud/One user, £287 exc VAT per year from islonline.com**
REVIEW Issue 361, p99

WatchGuard Firebox M390

Combines strong performance with an incredible range of security measures all at a competitive price. **Appliance with 1yr TSS subscription, £4,273 exc VAT from broadbandbuyer.com**
REVIEW Issue 360, p100



Art theft in the modern world



Dick Pountain is editorial fellow of *PC Pro*. You can see six of his abstracts at tinyurl.com/363abstracts and hear his Kaprekar tune at tinyurl.com/363kaprekar. Email dick@dickpountain.co.uk

Whether it's music or art, we're entering an age where matters of ownership are almost as blurred as fluid art on Instagram

When I'm not writing this column – which let's face it is most of the time – I perform a variety of activities to keep me amused. Apart from walking, cooking, reading, listening to music (live and recorded) and playing guitars, I have a couple of computer-based “hobbies”. Namely making computer-generated music and computer-generated pictures (non-moving).

I recently restarted work on my Python-based computer composition system *Algorhythmics* – which I described back in issue 306 – after a four-year rest. What inspired me was a YouTube video about the Indian mathematician D R Kaprekar and some interesting numbers he discovered, so I set up *Algorhythmics* to compose a short piano sonata around two of his numbers. While I'm biased, I think it sounds like a pleasing mashup of Ravel, Janáček and Satie.

I've been documenting my efforts at visual art in this column for over 20 years as I've marched through successive generations of paint software, from *PaintShop Pro* to *Photoshop Elements* to *Sumo Paint* to *ArtFlow*. I loved art at school and can use both paint and pencil reasonably well, but I've never been tempted to use either seriously since I discovered the computer (any more than I'm tempted to write articles with a quill pen since I discovered the word processor). The crux is editability: once you discover the infinite flexibility of digital imagery it's hard to give up this ability to experiment, redo and correct without wasting paper, canvas and paint. Images on a screen certainly lack the texture of

proper paintings, but then I'm strictly an amateur with no realistic ambition to make a living selling my work.

I've also been into photography since the 1960s, and my computer explorations began by processing snaps to make them look like paintings. This taught me how to use layers and blend modes to take total control of both the colour and tonal content. Later I began using this knowledge to create purely abstract images.

It won't have escaped anyone in the habit of watching Instagram, Facebook or YouTube reels that there's a remarkable revival of abstract painting going on right now among the social-media-savvy younger generations. Unlike me, they're not working in the digital domain but rather in the messy and expensive domain of wet paint. Under various labels such as fluid art, spin art and poured art, they're making dynamic action paintings – Jackson Pollock style – by pouring multicoloured acrylic paints onto a canvas, manipulating it using palette knives and then spinning and tipping it to produce a finished image. Often they incorporate silicone-based additives that introduce cell-like patterns of bubbles, and the results have a very particular biological look.

Some of them are very attractive indeed and nearly all are highly decorative. I doubt many of these folk consider their products to be high art but they are highly saleable, and that's on top of any revenues that derive from successful social media hits, which is just as well as the costs in canvas and acrylic paint must be considerable.

My own tastes lean towards early 20th-century modernist abstract art, especially Wassily Kandinsky, Paul Klee and Sonia Delaunay. I don't set out to imitate their works but merely play around using

“I'm not at all tempted to go in for fluid art to make money, even though those attractive canvases are more readily marketable than digital prints”

digital processing on a starting image, which could be a photograph, a clip from a website or a digital image that I draw by hand. Mostly I just use a mouse nowadays (I've had several Wacom tablets in the past) since my starters are so simple. Another way I sometimes start is by using *Zen Brush 3* on my Samsung Galaxy Tab, a delightful finger-painting program with extraordinarily realistic watercolour bleeding effects. I send the result to my Chromebook via Android's Nearby Share. Then I spend some time layering, blending, smudging and slicing until I see something I like, which does indeed tend to mean something that reminds me of one of my modernist mentors.

I'm not at all tempted to go in for fluid art to make money, even though those attractive canvases are more readily marketable than digital prints. That's not only because I don't have a garage in which I can splatter paint up the walls, but also because whenever I watch these artists at work on Facebook, more often than not I find the earliest part of a new work the most pleasing – then they keep adding too many colours and overdo it.

While watching one particularly spectacular piece I hit “Watch Again”, then hit Pause to stop it at an early stage I liked better, took a screenshot and used that as a starter for my own piece. This potentially raises a novel legal issue about copyright and plagiarism: I froze a moment in time that didn't make it into the final painting, so was I really stealing?

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“There's a remarkable revival of abstract painting going on among the social-media-savvy younger generations”

Ten years of WFH has taught me a lot



Byline: Nicole Kobie is PC Pro's Futures editor. She's not joking about the naps. We all need more naps. X@njkobie

If you're hoping for advice on standing desks and comfy chairs, then move along. But if you want to improve your life, you don't need to wait ten years

I used to really love going into the office: PC Pro is a fun group of people, my commute was a doddle, I lived in a small flat so it was nice to go anywhere else, and most of all, I was young. Alas, that hasn't been the case for some time, and ten years ago I was given the opportunity to go freelance. That's a euphemism, but I was delighted – I needn't leave my house, I could travel whenever I wanted, and nap every day, while still doing the work I love so much. What more could you want from life?

In those ten years, what have I learnt? There's the practical, to start with. Get a comfy chair and a real desk – none of this sitting at the kitchen table nonsense; that will destroy your back. Invest in proper broadband and a Wi-Fi router that actually supplies consistent, strong connectivity or you'll spend your days annoyed and frustrated. And take breaks: go for a walk, do your laundry, clean the bathroom, have lunch with a friend. It doesn't matter, but get away from your desk every now and then.

Those are the basics, and I'm confident they apply to most of us,

“I have actively walked away from lucrative projects because they were driving me up the wall”

wherever we work. But this is old hat to most people: pandemic lockdowns meant office workers spent months Zooming from home, and the rise of hybrid working means many still do for a few days a week. You know all this, though, don't you?

So forget tips and tricks. At any rate, the biggest lessons I've learned working at home for myself go far beyond personal productivity and posture. There are two lessons I think are worth sharing, one focused on

working for yourself, and the other centred on flexibility.

The best bit of working for yourself – freelance is what it's called in my industry, but for many of you it will be contract work – is that you are your own boss. Of course, sometimes it will feel as though you have many different managers making demands on your time, but they're not really your boss, and you don't need to do anything they say. It's true.

Don't like a client? Never work with them again – or even better, quit. This is much easier if you've managed to sock away a bit of savings, as it's difficult to refuse work when you're not sure how your mortgage is going to be paid. But when a client's bad behaviour becomes too much to bear, I don't need to make an HR complaint. I just say no – and gosh, it feels great. I have actively walked away from lucrative projects because they were driving me up the wall. I have quietly ended working relationships after an editor made unethical requests. And people who stress me out, I am done with you.

Of course, freelance life is hard. It's nerve wracking when work dries up and pitches go unanswered. But that's a stress factor I can manage myself. I can pitch more, find temporary work, start a fresh project and

so on. Employees can't simply fix their boss's arrogance, bullying or outright stupidity. Believe me, I have tried. Saying no is easier.

The second lesson is about the joy of flexibility. Cramming your responsibilities, chores and joys into a few hours after work in the evening is a hard way to live. Taking advantage of a slow time at work to do the laundry or organising your life to have more time with the kids feels luxurious, though it should be the norm.

And beyond the practical benefits, there's a change in mindset. When you repeatedly put off work in favour of taking a nap, hanging with the kid, going for a run or whatever else is a real priority in life, you start to realise how much work dominates not just our time but our headspace. Work is not the most important thing in most of our lives. Dressing up, travelling to a special place, and spending the bulk

“Work is important. But take a step back and it's easy to see how we could have happier lives by admitting that what we do could wait a few hours”

of our waking time focused on tasks that a whole bunch of other people are also focused on – it all skews our perception of the value of what we do.

Work is important. It gives us fulfilment and pays our bills. But take a step back and it's easy to see how we could have happier lives by admitting that what we do could wait a few hours, or maybe until tomorrow.

This isn't always true: if you're toiling away on a project to solve climate change or cure cancer, please keep at it. If you're working on a passion project, a new product, or launching a startup, work may well reasonably take precedence over sleep, for a time at least. That's fine, if it's an active choice.

But the rest of the time, the advice I offer employees or freelancers is the same: don't work for jerks; learn to say no, fearlessly; and realise the value of your own time. It worries me that I had to learn this, so if you haven't yet, here's the lesson for free. Whether you work from home in your pyjamas or commute into a corporate office, you deserve to be happy. And to take more naps.

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Google's lost: call off the search party



Barry Collins is worried he's becoming something of an AI fanboy. Send human contact to barry@mediabc.co.uk.
X @bazzacollins

AI alternatives to search pose an enormous threat to Google and the entire web publishing model

If you read the news on p10, you'll see the US Department of Justice is plotting novel ways to tear Google asunder. How best to hobble Google? Leave it be. It's doing a stand-up job of sinking the business all by itself.

A huge proportion of Alphabet's revenue comes from Google search. In Q3 2024, about 57% of Alphabet's \$77 billion revenue came from search – down from the 80% or more it used to be, but still far more than YouTube, cloud or any other revenue streams. To put it plainly, search is the business they don't want to screw up.

Yet screwing it up is precisely what they're doing, predominantly at the altar of AI. I was skimming through Reddit the other day and someone had posted a screenshot with the thread title "Google is over". It showed an image search for a baby peacock in which the vast majority of the top results were plainly AI-generated.

Being the sceptical bugger I am – I don't respond to fire alarms until my eyebrows start singeing – I thought the screenshot must have been doctored or the search manipulated somehow. But when I searched for "baby peacock" up popped a stream of AI-polluted results, including the top two images.

Now, this might be a freak result, an example where a shortage of actual photos of baby peacocks is being filled by AI images, but I'm sure we've all seen an increasing number of AI-generated results – both text and images – returned in Google searches.

In fact, Google is increasingly doing this itself. No doubt wary of the threat from ChatGPT, Copilot and the like, Google is stuffing output from its own Gemini AI at the top of many

search results pages. If I enter queries such as "what is the minimum wage?", "who is the director general of the BBC?" or even "who is the editor of *PC Pro*?", Gemini AI provides the answer. I don't go anywhere near a website to find out.

Anyone who's ever worked in web publishing knows that the top slot in a Google search result is the only place to be. Studies vary, but the top-of-page result gets somewhere between a quarter and a half of all the clicks for that search term, with top ranking proving much more valuable on mobile. Once you get down to about fifth position you're an also-ran, maybe getting 1-2% of the clicks. Top is everything – and now Google's filling that slot with long, expansive AI answers that occupy almost the entire screen on mobile. The web publishers are nowhere.

Why would that bother Google, you might wonder? Well, Google doesn't only sell advertising space on its results pages, it sells advertising space on websites, too. There's barely a commercial web publisher out there that doesn't use Google AdSense in one form or another, even if it's only for backfill when their other networks have run dry. Less traffic to websites means less revenue for Google.

Certain web publishers tell me that recent Google algorithm changes and the arrival of AI have dramatically decreased their search traffic. Some report it's as much as 50% down. That's a catastrophic drop in income for the publisher and, indirectly, for Google as well.

And I suspect it will only get worse. Increasingly, these days I pop more complex search queries into ChatGPT not Google, because I know ChatGPT will do a better job of

“For the first time in 25 years, Google isn't necessarily my go-to service when I need to dredge up information about something”

understanding what I'm hunting for. You always have to check the sources, to make sure ChatGPT hasn't "hallucinated" the answers, but it's increasingly accurate.

The AI services are well aware of the opportunity. OpenAI is conducting a public beta of SearchGPT, which is a naked attack on Google search. It's more focused on delivering timely information than ChatGPT, such as current weather conditions, and unlike Google it allows you to ask follow-up questions about the results.

Then there are services such as Arc Search, a spin-off of the Arc browser that is now on both Android and iOS. This creates brilliant little AI-generated summaries from search queries, so if I search for, say, "Logitech MX Creative Console", I get a summary of what the device does, which OSes it works with, its price, key features and loads more useful information. It's exceedingly useful for quickly distilling news stories, too.

AI alternatives such as these are a massive threat to Google – and the wider web publishing model. For the first time in 25 years, Google isn't necessarily my go-to service when I need to dredge up information about something. And given the way both Microsoft and Apple are building AI into their operating systems, I can see that soon becoming the case for the majority of people.

We don't need the competition authorities to dismantle Google. The AI's going to get there first.

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“Anyone who's ever worked in web publishing knows that the top slot in a Google search result is the only place to be”

“Ticks all the boxes”



“Fantastic quality”



“Outstanding combination!”



“The **best** printer”



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“Reliable and trouble free”



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Readers' comments

Your views and feedback from email and the web

Speak up

With the recent poll on the use of smart speakers and the previous article on home automation I feel that there is a big miss in some of these things, and I only hope we can get better.

As a husband of a wife who is disabled, I can see that there are bits that don't link up. Yes, you can turn the lights on, or a socket, but when it comes to adjusting the devices the automation stops working. Can you turn the toaster up to ten, change the channel on the TV, turn the volume up and down, turn on the hairdryer?

I assume you can if you buy new equipment – that is, a new toaster, TV or hairdryer – but where are the devices we can install that allow existing equipment to integrate with home automation? We need to ensure that the links are there between the

BELOW Where is the technology to turn dumb devices smart?



existing equipment and the new automation that is coming up.

I hope that this will improve over time, but we need more connection between our smart speakers and our smart devices (and to make our non-smart devices smarter). **Stuart Dixon**

Driven to distraction

I read with interest Jon Honeyball's back page comments on future tech (see issue 362, p130) and the reference to Ford patenting spyware in cars to enable them to target drivers with advertising. While I see this as them shooting themselves in the foot, I suspect it's just a sign of the way things may develop. From a PR perspective it would be better to patent NOT to use such software!

On the broader theme of Jon's article, it is by chance that I was talking with my brother recently about how the world would look when his newborn grandson is our age (second half of our 60s). When we grew up there were two TV channels, regular walks around the streets to get in a queue for the local phone box, and three radio stations (until those naughty pirates entered the scene).

I simply cannot imagine how things will develop in the next ten years, let alone the next 60. **Peter Bird**

VoIP providers for all

With the demise of the conventional landline I think it's time that *PC Pro* printed a review of VoIP providers who cater for ordinary domestic customers.

While most broadband providers offer an add-on telephone contract, these aren't always cheap. I set up a Sipgate account a couple of years ago that has

no monthly subscription provided you make at least one call in a six-month period and very competitive call rates, including to overseas numbers. However, they have stopped new customers using this. Now new customers pay a monthly subscription.

While your A List does include VoIP services for small businesses, many of your subscribers would benefit from a review of low-cost VoIP services for domestic customers as an alternative to paying around £10 per month for a telephone service through a broadband account. **Simon Read**

Editor-in-chief Tim Danton replies: Thanks for this, Simon. It's a great idea and we'll look into it.

Dumb monitors

In 2015 I bought a rather expensive 31in LG 4K monitor (31MU97). Clearly aimed at the professional user, I chose it for the quality of screen with respect to my photography hobby, and for that purpose it's been a joy to use. Over time it suffered power supply failure and was repaired several times under warranty, and a paid-for repair when again it failed.

It has died again, and having just contacted LG support I found that they no longer offer servicing for monitors over six years old – to all intents and purposes, the monitor's a write-off.

You might want to add this aspect to your future monitor reviews as I'm sure I'm not the only one expecting to get more than just six years service out of what is supposed to be a professional piece of kit. **Chris Hobson**

Fixer-in-chief Lee Grant replies: Sadly, Chris, your experience is typical. An Open Repair Alliance report (tinyurl.com).

Star letter

Prompt response

As part of your "AI wants your job!" feature (see issue 362, p26), in the box on p32 under the heading "Prompt like a pro", there is a statement in large text: "You've got to give it tight instructions on how you want it to behave."

How true. I recently solved a major problem with a web page using a coding AI site. This was my first attempt at using AI,

and it was an interesting if long process, and my CSS skills are very basic.

Through ignorance I started out giving it vague instructions along the lines of "Fix this problem". Unsurprisingly, it supplied a rubbish answer. However, as I began to be more specific with what the problem was, an interesting conversation developed. One that over about 30 minutes not only solved the problem, but made me want to thank the entity behind this "magic".

I've always realised the importance of planning and reviewing – often over and over

again. While this seems basic, it's extremely important with AI, which doesn't know anything about my project or its scope; doesn't know the structure of my dilemma; doesn't know what I've already developed; and doesn't know how I think.

So of course I've got to tell the thing almost everything, including why I want to watch the All Blacks play the Springboks in the Rugby World Cup Final. But when I do this, the results can be exactly what I want, or so close that even I can finish it from there. **John Coates**

This month's star letter writer wins a Cherry KC 200 MX mechanical keyboard, worth £80, recipient of a five-star review and a *PC Pro* Recommended award. Email letters@pcpro.co.uk



Readers' poll

To tie in with our buyers' guide from p40, we asked readers if they had ever bought a Raspberry Pi and, if so, what they used it for.

Yes
63%

No
37%

com/363repair) discovered that the average lifespan of flat screens is only five to ten years, with a repair success rate of just 31%. In the UK, when a device repeatedly fails under warranty, repairs can be refused and refunds sought from the retailer (note that the manufacturer is off the hook). Current EU law says spares must be available for between seven to ten years, which is too late for your LG, but its replacement has the potential for a longer life. And in terms of reviews, it's well worth cutting out and keeping this month's Awards feature (see p28) as this gives you an instant guide to the reliability of manufacturers across monitors, laptops and more.

Smart monitors

I liked your review of the Samsung Smart Monitor M8 (see issue 361, p70) as I've been looking at this myself, but it only comes in a maximum size of 32in. I see Samsung has released a 43in version in the US, but it's not available to us yet. This got me wondering: with modern OLED technology, is there really any difference any more between using a smart PC monitor as a TV and using a smart television as a PC monitor?

Mike Halsey

Contributing editor Jon Honeyball replies:

It's a good question, but I suspect my answer will disappoint you. The first problem is that refresh rates can be an issue, as TVs simply aren't designed to run at the high refresh rate we're used to on Windows and macOS computers. So you'd want to check that. And a 4K resolution might be enough, depending on how far you're viewing from, but maybe not.

But perhaps the biggest problem is that TVs come with image sharpening and various other tweaks that work well for video (most of the time), but you'll probably find you get nasty oversharpening artefacts in the OS and apps. So, my advice is to stick with a monitor designed for daily computing.

Cheeky cat

It's a shame you didn't tell us which "AI" generated the headphone-wearing cat image on the cover of issue 362, if only so we can avoid it!

As any truly intelligent entity will tell you, headphones work far better when they cover the ears compared to being worn on the cheeks.

Alan Dennis



It's safe to say the Raspberry Pi has been a hit with PC Pro readers. But are they sitting in a box unused or being put to good use? "Bought two of the originals when they were new – for the kids to use and learn with," Nick Whittle told us. "Hooked up to a keyboard, mouse and monitor they made great little computers with just enough power for writing games. Was blown away by the creativity of a game one child created. The other never showed any interest."

That's exactly the use that Eben Upton intended the Pi for, but it should come as no surprise that our readers use them for all sorts of things. "I've got a few," wrote Martin Ruston. "One's a home assistant server, another has Kodi on it to stream DVDs and CDs, while another has Docker and Portainer on it so I can experiment with things."

Elsewhere, we saw votes for the Pi-hole web filter, Home Assistant and even a replacement PC: "I think that an 8GB Pi 5 with a PCI-E extender to an NVMe SSD would make a very usable desktop machine for LibreOffice and web browsing use, especially in something like the Argon case" said Geoff Campbell. And we can only applaud andy m (@bigajm on X) for "downloading my usage data from Octopus for my own slice 'n' dice reporting" and more.

Mike Collins started equally brightly. "Got one years ago and used it as a media server under the TV. Very proud of the Lego case my son and I created for it. Now retired in among my drawer of obsolete cables." And several people talked about their Raspberry Pis sitting unused, such as Marcin Gorecki: "I bought three R Pis. I got a few evenings of fun out of them. Now they gather dust." Don't worry, though, Martin, as we'll have more Pi features to come in the future.

“I have 12+ R Pi 4Bs used for meteor detection and Allsky cameras.” **Edward Cooper**

“Yes. I built a Plex server for the motorhome and also an aurora detector.” **Mark Newton**

“I built a @recalbox retro games console with a Raspberry Pi.” **Darren Davies**

“Bought a Pi 4 a few years ago to run my 3D printer.” **Rez Manzoori**

“I bought the first one. My son stole it and I never saw it again! He now works as a programmer.” **@quillon1 on X**

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TECHNOLOGY
EXCELLENCE
AWARDS **2024**

WINNERS

BRANDS YOU CAN TRUST

Whenever you buy something in the coming year, why not draw on the experience of thousands of discerning buyers?

We're so used to glancing at star ratings on websites when deciding whether or not to make decisions, it's almost become second nature. It's the modern shorthand for "what do other people think?", but the trouble is that you don't know who those people are. Some may be genuine, but others were given the products for free – and some will simply have been paid to write a positive review.

PC Pro has always offered a different route, basing our reviews on our own tests and our knowledge of the sector. But every year we do something that wouldn't otherwise be possible: we ask thousands of people about their buying experiences. Not whether the product turned up on time (unless it's part of our analysis of online retailers), but what

happened when something went wrong. Were they happy with the service they received?

We also ask about how happy they are with the performance and quality of the products they've bought. And would they buy from the same company again? This gives us something unique in the UK: a deep dive into people's happiness when it comes to technology.

We couldn't do this without the support of our readers, so allow us to send out an individual message to each of you as you read this: thank you for taking part. If you didn't win one of our prizes, hopefully the data-packed tables over the next few pages will be ample reward.

CONTRIBUTORS: Barry Collins, Tim Danton and 5,937 of our readers

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BEST PC MANUFACTURER

WINNERS CHILLBLAST, SCAN
HIGHLY COMMENDED APPLE, PCSPECIALIST

While you can glean a lot about a company from the table alone – whether for Best PC Manufacturer or any of the other categories – sometimes you need to hear direct from people to fully comprehend what makes it stand out. And for Scan, joint winners of this year’s award, it’s not merely about speed or reliability, but customer service. “Scan are amazing!” wrote Benjamin Harris, echoing many others’ exact same sentiments. “Their customer support is fantastic and any problems they are very quick to help.” Although we thought this brief comment from Rishen Raja also says a huge amount about the pride it has in its machines. “Great experience working with Scan,” he said, “[and] amazing cable management!”

It’s the speed of its machines that ultimately lifted Chillblast from Highly Commended to Winner, with the vast majority of its customers declaring themselves very satisfied with the performance of their desktop PCs. But speed alone isn’t enough, so it’s worth taking notice of its excellent reliability results and high levels of customer support (despite changing ownership in 2024). “Excellent pre and post-sales support,” David Ralph told us, while Katherine Starket commented that “everything was top notch”. Michael Hoare added: “The staff are very knowledgeable, and with a friendly and approachable manner.”

	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	BUY AGAIN?	OVERALL
CHILLBLAST	94%	98%	92%	99%	95%	95%
SCAN	97%	96%	91%	95%	99%	95%
PCSPECIALIST	95%	94%	92%	94%	97%	94%
APPLE	93%	96%	82%	94%	99%	93%
DELL	82%	90%	85%	87%	96%	88%
LENOVO	77%	89%	87%	88%	98%	88%
CYBERPOWERPC	83%	90%	82%	92%	92%	88%
ACER	80%	86%	87%	82%	97%	86%
HP	79%	86%	87%	87%	94%	86%

It’s tight at the top, with Apple and PCSpecialist only narrowly missing out on the Winners’ accolade. “Paid attention to detail and their work-in-progress photos are a great tool to check if rigs have been built right,” said Penny Goodhand of the British retailer. And Linda Tyler clearly agrees: “From configuration to build to delivery, the team at PCSpecialist were on hand and in touch making sure everything went smoothly.”

While it wasn’t such an awe-inspiring set of results for the international names, in part because they can’t offer that level of customisation to buyers, it’s worth highlighting that in general people are pretty happy with their desktop PCs – and we were pleased to see that over 90% would buy again from each and every company here.





BEST LAPTOP MANUFACTURER

WINNER APPLE

HIGHLY COMMENDED MICROSOFT, SAMSUNG

If you're looking for a laptop brand you can trust, it's hard to look past Apple. It sits at the top of the charts for reliability, speed, battery life and customer support – little wonder that 98 out of 100 MacBook buyers would stick with the brand with their next purchase.

One aspect stands out for Phil Asquith. "The [MacBook's] battery life is unbelievably good compared to a Windows machine, lasting well over a week on a charge and used every day." A telling remark if you look down the battery life column, where you'll see that all the Windows laptop makers lag behind for satisfaction – something we expect to see slowly improving over time, now that AMD, Intel and Qualcomm have belatedly realised that Windows users care about life away from the mains, too.

That brings us to longevity. "My last Apple laptop is still going strong after nine years," Nick Harrison informed us. "My Windows laptop was broken after two-and-a-half years and it cost the same." The only area where Apple's otherwise loyal fans criticised the company was lack of ports. "Could do with more," wrote John Wright, succinctly.

Of the chasing pack, Microsoft and Samsung stood out. "Super light and [it has] an amazing screen," wrote Jon White of his Surface. And while people often commented about the expense of Microsoft's laptops – as reflected in a low

	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	BATTERY LIFE	BUY AGAIN?	OVERALL
APPLE	90%	95%	79%	94%	92%	98%	91%
MICROSOFT	83%	92%	76%	87%	82%	96%	86%
SAMSUNG	80%	88%	83%	87%	81%	92%	85%
LENOVO	77%	85%	84%	85%	77%	94%	84%
ACER	80%	88%	85%	81%	77%	92%	84%
ASUS	76%	87%	84%	85%	72%	96%	83%
DELL	79%	85%	80%	85%	76%	93%	83%
HP	77%	84%	82%	81%	77%	92%	82%
MSI	80%	79%	81%	87%	72%	93%	82%

value-for-money score of 76% – its website is worth checking for flash sales.

Peter Rudd grabbed a "very good deal that couldn't be missed, but I wouldn't have bought it even at a half retail price". That sounds like one heck of a bargain.

Samsung, meanwhile, is winning fans for its integration with its other mobile hardware. Sameer Thapa praised the company for its "modern designs" and "vibrant displays" but it was "the integration of their hardware with their ecosystem such as smartphones and tablets" that drew particular praise.

The chasing Windows pack isn't far behind, whether that's Acer, Asus, Dell or Lenovo. Whether they'll ever be able to catch up with Apple is another matter.



BEST OF BRITISH LAPTOPS

WINNER PCSPECIALIST

We didn't receive enough feedback about British company PCSpecialist to include it in our main list, but the company stood out from its UK rivals for the levels of satisfaction it received from its laptop-buying customers, and that's why we gave it this special award.

PC PRO TECHNOLOGY EXCELLENCE AWARDS 2024 BEST OF BRITISH



BEST TABLET MANUFACTURER

WINNER APPLE
HIGHLY COMMENDED SAMSUNG

If we needed to sum up people's thoughts about iPads in one response, it would be this: "The new 11in iPad Pro M4 is an amazing piece of kit, but very expensive and overkill for daily tasks," wrote Robert Barr. "Nevertheless, I do not regret upgrading and enjoy using it." And this begrudging love for Apple's incredibly expensive but also supremely high quality tablets, along with an unparalleled selection of apps and accessories, ran through our survey. What's more, iPads last: "Will be purchasing a new one soon as this one is nine years old with the original battery," said Andrew Alton.

But if Apple thinks it can sit back and relax it need only look at the Smartphone category, where it comes second to OnePlus. In the meantime, Samsung is its big tablet rival, and a phenomenal 95% of people would buy a Galaxy Tab again. Carol Wilson among them: "Excellent for travelling light, easy to set up and use, very stylish. A very good buy." Heather Jacobs agrees: "One of the best things I've bought in a long time. I spend as much time using it as I do my main desktop."

Lenovo trails a distant third, with its buyers seemingly less enthused about their purchase. People did praise build quality – Bryan Hall said that his was even "tough enough to deal with [both] adults and sometimes clumsy children" but it couldn't quite match Amazon's big selling point: price. "Extremely good value for money, especially for children," said Trevor Toms. We'll give the final word to Vascar Barmanroy, who praised Amazon's "value for money, especially if you're not using power-hungry applications. Great for watching movies on the go."



	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	BATTERY LIFE	CHOICE OF SOFTWARE/ACCESSORIES	BUY AGAIN?	OVERALL
APPLE	86%	94%	79%	91%	85%	85%	97%	88%
SAMSUNG	80%	90%	81%	85%	82%	80%	95%	85%
LENOVO	73%	83%	83%	76%	81%	74%	88%	80%
AMAZON	76%	82%	86%	71%	78%	61%	82%	77%

HOW YOU DECIDE THE WINNERS

Forgive us, for we say this every year, but PC Pro doesn't decide the winners of the Technology Excellence Awards: you do. It's thanks to thousands of readers taking part in our detailed survey, across three months, that we can generate the detailed tables you see on these pages.

Fundamentally, we aim to gauge your levels of satisfaction with the companies whose products you buy. When it comes to printers, how satisfied are you with print quality? Or the reliability of your broadband? How happy are you with the photos your phone produces?

We then crunch the figures to create the percentage scores you see in the tables. The maximum score a company can receive is 100%, where a reader declares themselves to be "very satisfied" with, for instance, customer support for their desktop PC. If they select "satisfied", that's a



score of 80%. And so on, until they reach "very dissatisfied", which is 0%. So a score of 90% could be 50 people saying "very satisfied" (100%) and 50 "satisfied" (80%).

For companies to appear in our tables, they must have at least 25 respondents. We also use methods to protect against "stuffing" or other manipulation where a manufacturer may try to bias results by encouraging only positive feedback. This year, we (together with an independent consultant) spent over two weeks analysing the data,

looking for anomalous results and discarding those entries. As a consequence, we believe that the scores you see are ones you can trust.

From p36, we also select our own Products of the Year. Chosen by PC Pro's editors, these are the standout products and services – from business laptops to workstations to AI innovations – from the hundreds we've tested over the past 12 months.



BEST NAS MANUFACTURER

WINNER QNAP
HIGHLY COMMENDED SYNOLOGY

The NAS category is dominated by two big beasts of the industry: QNAP and Synology. Synology took the crown in 2023, but it's been wrested back by QNAP this year, with Synology taking the consolation of a Highly Commended award.

QNAP beat its rival in every category in this year's survey, with customer support offering the widest margin between the two. An 89% satisfaction score for support is backed up by every single one of the QNAP customers we surveyed saying they would be happy to buy from the company again.

We can see from the comments that many readers are deciding between the two rivals when choosing a NAS. "QNAP seems to produce higher spec NAS devices for the same money as Synology," said Paul Trickey. "Synology software is supposed to be easier for the beginner, but frankly I didn't find QNAP setup too difficult so I'd go with them again." Derek Abbott demurred slightly, arguing QNAP's "setup instructions could be clearer", although Jonathan Groves found QNAP's NAS "much easier to manage than Synology".

A few Synology buyers gripped about the price of the devices, although Ray Collington thought it was money well spent. "Love Synology and especially the DSM software and all the apps available," he said. "This is a far better storage solution than being ripped off by cloud providers."



	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	FEATURES/ OS/APPS	BUY AGAIN?	OVERALL
QNAP	89%	94%	88%	90%	93%	100%	92%
SYNOLOGY	81%	91%	86%	86%	92%	96%	89%
OTHERS	65%	80%	80%	82%	75%	82%	77%

Note that we also received feedback on Asustor and Western Digital, but the sample sizes weren't big enough to include them in the table. The "Others" result, however, shows how the rest of the industry (including Asustor, Western Digital and a handful of other brands) compares to our award winners.

BEST ROUTER MANUFACTURER

WINNERS DRAYTEK, UBIQUITI
HIGHLY COMMENDED FRITZ!BOX

DrayTek is becoming a fixture at the top of our router manufacturer award. There are no chinks in its scores, but a 96% satisfaction rating for reliability is the score that stands out. Reliability is everything when it comes to a broadband connection, and that's the main reason DrayTek remains at the top of the pile.

"They just work and work well," said Martin Packer of DrayTek's routers, a sentiment echoed by Simon Reynolds. "I've been using DrayTek comms equipment for many years, very happy with them," he said.

Anyone who listens to the PCPro podcast will know of Jon Honeyball's fondness for Ubiquiti and its "networking gear for grown-ups", and readers make that distinction, too. "The UniFi



ecosystem is brilliant but is really aimed at the home enthusiast or SMB market," said Martin Raeburn.

Jodi Lowe buys second-hand Ubiquiti equipment. "Don't think it's worth the full price, but it is the most stable Wi-Fi point I've had and handles over 60 Wi-Fi smart devices where other points have failed."

Fritz!Box, which supplies many of the routers for broadband award winner Zen, claims a Highly Commended award. Range is the only slight weak spot in its scores, failing to match the 90%+ scores of DrayTek and Ubiquiti. "Fuller advice on positioning of mesh repeater would be helpful with respect to internal walls," said Tim Marriott.

	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	RANGE	BUY AGAIN?	OVERALL
UBIQUITI	82%	95%	90%	96%	95%	97%	93%
DRAYTEK	91%	96%	88%	93%	90%	96%	93%
FRITZ!BOX	91%	94%	89%	92%	86%	96%	91%
AMAZON EERO	85%	91%	84%	93%	86%	84%	87%
TP-LINK	79%	88%	88%	87%	85%	95%	87%
ASUS	84%	86%	79%	93%	89%	89%	87%
NETGEAR	74%	84%	71%	89%	84%	85%	81%

BEST ONLINE RETAILER

WINNER PRINTERLAND
HIGHLY COMMENDED SCAN

Given how much grief printers cause, it's staggering that any retailer with "printer" in its name can top a customer satisfaction chart. But Printerland is clearly a winning destination for *PC Pro* readers, with an overall score of 98% sealing the win in one of the most competitive categories.

Strong scores across the board propel Printerland above last year's winner, Broadbandbuyer.co.uk and perennial *PC Pro* award botherer Scan.

Claire O'Kane was impressed with both Printerland's website and customer service. "Brilliant website with an extra-detailed filter system that allowed me to tick off all my listed needs and narrow the choice down to a few printers," she said. "Ordered around 3pm and it arrived by the next day. First time I've used this company and would definitely use again."

Daniel Learmouth was equally enamoured. "They were superbly helpful during the ordering process, and followed up on my order a few days later to check everything was alright," he said. "Exemplary service."

Scan is a long-term *PC Pro* reader favourite, a British PC firm that defies the chill winds of the industry by consistently delivering superb service – as evidenced by 99% of customers saying they would be happy to buy again from the company. No mean feat when you're supplying hardware as temperamental as high-end gaming PCs!



	OVERALL SATISFACTION	CUSTOMER SUPPORT	SPEED/QUALITY OF DELIVERY	RE-USE?	OVERALL
PRINTERLAND	97%	97%	98%	99%	98%
SCAN	95%	93%	94%	99%	95%
BROADBANDBUYER	95%	90%	94%	99%	94%
JOHN LEWIS	93%	89%	91%	98%	93%
APPLE	92%	88%	91%	99%	93%
CCL	92%	89%	89%	97%	92%
NOVATECH	94%	88%	92%	93%	92%
LAPTOPS DIRECT	91%	84%	90%	100%	91%
OVERCLOCKERS UK	90%	85%	88%	95%	90%
EBUYER	88%	83%	87%	97%	89%
ARGOS	88%	80%	88%	99%	89%
AMAZON	86%	78%	91%	99%	88%
BOX	86%	83%	88%	95%	88%
DELL	87%	81%	83%	95%	87%
VERY	84%	80%	83%	95%	85%
LENOVO	87%	79%	82%	91%	85%
HP	84%	75%	85%	92%	84%
CURRYS	82%	75%	81%	94%	83%
EBAY	82%	73%	77%	99%	83%
MICROSOFT	80%	70%	82%	96%	82%
BT SHOP	77%	69%	73%	78%	74%

BEST WEB HOST

WINNER 20i
HIGHLY COMMENDED ZEN

20i makes it two years on the spin as your favourite web host, once again seeing off perennial favourite Zen.

If you're going to outperform Zen, you simply have to get your service spot on, and a 95% satisfaction rating for 20i's customer support is indicative of a company doing just that. In fact, there's not a weak spot in 20i's scores, with reliability, value for money and speed all scoring 94% or better.

"I cannot say enough how good 20i have been over the many years I have used them, they are exceptionally good in every area," said Stephen Bruckshaw. "I have been using hosting companies for over 20 years and of all the many hosting providers I have tried, no-one comes close."

Zen won't be unhappy with its scores either, logging above 90% in every single category. "Their customer service is second to none, and they made the process of transferring from my previous (American) host really easy, and there have been no issues since," said Jocelyn Lavin.

Francis Burns agrees. "Technical support is superb – with minimal handoffs and staff who really know what they are talking about."

20i and Zen are well ahead of the pack in our table, although it's interesting to see WordPress.com climb to third place. Although its customer support scores could be better – 75% is relatively low – a very healthy 96% of customers said they would be happy to buy from the company again, which shows the dedicated WordPress host is doing something right.

Wix, another of the industry's big beasts with a focus on getting people online as easily as possible, slots into fourth place, showing that there's an appetite for the services that give you the tools to build a web presence with little fuss.



	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	BUY AGAIN?	OVERALL
20i	95%	95%	94%	94%	97%	95%
ZEN	94%	94%	92%	92%	97%	94%
WORDPRESS.COM	75%	87%	83%	82%	96%	85%
WIX	84%	87%	75%	82%	95%	85%
FASTHOSTS	78%	84%	78%	80%	88%	82%
MICROSOFT (AZURE)	78%	81%	78%	82%	81%	80%
123REG.CO.UK	76%	81%	73%	78%	86%	79%
GODADDY	75%	80%	73%	73%	84%	77%
IONOS	74%	81%	74%	79%	74%	77%
BT	75%	77%	76%	78%	76%	76%
1AND1.CO.UK	70%	80%	69%	76%	80%	75%
TSOHOST	69%	75%	76%	77%	77%	75%

BEST CLOUD STORAGE WINNER BACKBLAZE HIGHLY COMMENDED AMAZON S3

Backblaze sits atop the *PC Pro* cloud storage table for yet another year, finishing head and shoulders above the competition. Compare its scores to big-name rivals and it's immediately obvious that sometimes buying from a specialist in a market pays dividends.

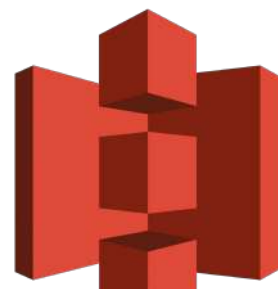
Reliability is surely the metric everyone pays attention to when it comes to online backup, and Backblaze's 96% satisfaction score is untouchable. It beats everyone else for value for money, too, which is a very compelling combination.

Steven Smith was at a bit of a loss when it came to rating Backblaze's customer service, though. "Their system is so easy to use that customer service has not been necessary for me," he said. There's also lots of praise for Backblaze's pricing structure for personal backups, where you pay a set monthly or annual fee per machine, irrespective of how much data needs storing. However, there were one or two gripes about no discounts on pricing for multi-machine households.

Amazon S3 is more business-oriented than Backblaze, but customers still trumpet its value. "Simple, cheap, effective. Can't complain," was the succinct verdict of Myles Offord, who needs to up his verbiage if he wants a job as a *PC Pro* reviewer.

BT's service thuds to the bottom of our table this year, after a mid-table performance last time out. And though Dropbox is arguably the best-known online storage firm out there, it too is struggling to lift itself from the nether regions for the second year in succession, with customer service and value for money both called into question by our readers.

Many griped that the jump from Dropbox's free to cheapest paid plan is too steep. "Repeatedly tries to fool me into buying more storage space by lying to me that my Dropbox is full when I am only ever using about 15% of it," said Douglas Bell.



	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	RECOMMEND?	OVERALL SCORE
BACKBLAZE	91%	96%	93%	90%	95%	93%
AMAZON S3	80%	91%	81%	86%	94%	86%
APPLE ICLOUD	79%	85%	78%	83%	89%	83%
GOOGLE DRIVE	75%	84%	82%	82%	90%	83%
AMAZON CLOUD DRIVE	78%	82%	80%	79%	88%	81%
BOX.COM	75%	82%	83%	79%	77%	79%
MICROSOFT ONEDRIVE	72%	80%	78%	79%	86%	79%
DROPBOX	71%	82%	73%	80%	87%	79%
BT	60%	67%	65%	69%	54%	63%

BEST BROADBAND ISP WINNER ZEN

Despite this being an era of huge upheaval in the broadband market, some things remain constant – such as Zen's place at the top of our broadband ISP league.

One of the so-called altnets (or smaller fibre providers), Hyperoptic, was nipping at Zen's heels last year. Alas, this year we didn't receive a sufficient number of responses from any of the altnets to put them in our final rankings (we need at least 25 responses for them to be included), but note this: one of the altnets in this year's survey outscored Zen in several categories.

It would have been a shock result had it won outright, because Zen has now claimed this award for 21 consecutive years, making it the most successful company in the history of these awards. And you only need to study the table to see its dominance.



Zen's across-the-board consistency is staggering. It's the only broadband provider in our rankings to score above 90% in any of our categories... and it scores above 90% in all of them.

Zen is "so easy to deal with", said Michael Godfrey. Despite issues occasionally cropping up with wholesale provider Openreach, "Zen deals with it all. Someone from their end takes control and responsibility for dealing with it, reports back to me on progress, and checks in on a regular basis until everything's back to how it should be." Gareth Green agrees, adding that Zen are "so much better in every way than any of our many previous providers". We could actually fill this entire article (all 11 pages) with words of adulation from its customers, but you hopefully get the message.

BT subsidiary Plusnet is the best of the rest this year, and this note from Andrew Nason hints at why it scored second for customer support. "I've just spoken to them," he wrote. "No waiting, straight through. They promised a call back within four hours but 30 minutes later they rang. What's lovely about Plusnet is that you can just call them and speak to someone, they offer good value for money but their support is top notch."

TalkTalk could learn a thing or two about this. Its abject customer support score of 57% plunges the bargain-basement provider to the bottom of our table this year, although there's not too much to separate it from some of the other big beasts such as Sky, BT and Virgin Media. It seems even stiff competition from the altnets isn't prompting the big players to up their game, which is disappointing – and reflected in their woeful "renew" results.

	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	RENEW?	OVERALL
ZEN	96%	96%	91%	92%	97%	94%
PLUSNET	83%	83%	77%	72%	84%	80%
EE	77%	77%	70%	75%	72%	74%
VODAFONE	69%	76%	72%	74%	80%	74%
VIRGIN MEDIA	59%	74%	57%	82%	75%	69%
BT	66%	76%	55%	67%	70%	67%
SKY	70%	70%	61%	64%	66%	66%
TALKTALK	57%	67%	62%	64%	60%	62%



BEST MOBILE DATA PROVIDER

WINNER 1PMOBILE

HIGHLY COMMENDED SMARTY

We say it every year, but when it comes to satisfaction with mobile data providers it's the virtual networks that outshine the very networks they're piggybacking on. In fact, this year's top two are the same pair that collected the gongs in 2023: 1pMobile and Smarty.

1pMobile has improved its scores since last year's winning performance, now being the only mobile network to meet the much-prized 90% overall score threshold. As you might expect from a network that trades on the "UK's lowest PAYG rates" of 1p per minute, 1p a text and 1p a MB, it scores most highly for value for money.

Paul Rendell said he uses 1pMobile "for personal [use] as well as three phones used for a non-profit that use mostly data. Works great and very cheap but also does VoWiFi and VoLTE, which some MVNOs still do not."

Alan Graham adds that the "service is cheap and reliable and



there were no unexpected costs when I travelled abroad in the EU".

Value is also a strong card for Smarty. "Great value monthly rolling deal – 60GB data, unlimited calls and texts for £10 per month.

What's not to like?" asks David Dunmore, auditioning for Lee Dixon's job on the Smarty ads.

1pMobile and Smart's excellent value scores should perhaps give parent networks EE and Three respectively food for thought about their own (at best) middling showings.

	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	4G SATISFACTION	5G SATISFACTION	BUY AGAIN?	OVERALL
1PMOBILE	86%	92%	93%	91%	87%	83%	100%	90%
SMARTY	85%	87%	95%	87%	81%	71%	95%	86%
GIFFGAFF	82%	89%	94%	86%	81%	65%	96%	85%
TALKMOBILE	82%	84%	93%	84%	84%	62%	100%	84%
LEBARA	80%	86%	95%	84%	80%	67%	95%	84%
TESCO MOBILE	84%	87%	88%	83%	79%	66%	93%	83%
ASDA MOBILE	80%	87%	86%	81%	79%	68%	96%	82%
ID MOBILE	76%	84%	91%	83%	78%	66%	91%	81%
SKY	75%	78%	80%	77%	74%	56%	78%	74%
EE	73%	79%	71%	76%	73%	64%	81%	74%
THREE	67%	74%	73%	72%	68%	58%	71%	69%
O2	68%	76%	69%	72%	68%	55%	74%	69%
VODAFONE	67%	75%	67%	71%	69%	56%	73%	68%

BEST PHONE MANUFACTURER

WINNER ONEPLUS

HIGHLY COMMENDED APPLE, HONOR

You might expect Apple to dominate phones as it does for laptops and tablets, but while it still gains a Highly Commended award, not everyone is happy. "Unimpressed that after just a year I discovered a (manufacturing) fault with the camera and Apple would not replace," wrote Ashley Harcourt. Add on regular complaints about price and you wonder at the astonishing 98% of people that would buy again.

In contrast, OnePlus customers are delighted with the value offered by their phones. And Martin Schwaller keeps coming back for more: "I've had a number of OnePlus phones over the years; all are superb." And it's not just about value. "I'm in a low signal area and reception on my OnePlus phone has been outstanding," Roy Holt told us.

Congratulations also go to Honor, which pipped OnePlus for value for money while also delivering for battery life and speed. "I bought this [Honor] phone to replace my Pixel 7 Pro, and it is so much faster and the battery life is amazing," wrote Michael Tott. If Honor can improve its camera scores, it could challenge OnePlus for the top accolade in 2025.



	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	SPEED	BATTERY LIFE	CAMERA QUALITY	BUY AGAIN?	OVERALL
ONEPLUS	90%	96%	92%	88%	89%	91%	95%	92%
APPLE	88%	93%	75%	95%	80%	90%	98%	89%
HONOR	77%	90%	93%	91%	93%	84%	89%	88%
GOOGLE	79%	89%	85%	91%	81%	91%	96%	87%
SONY XPERIA	80%	92%	84%	81%	88%	92%	97%	87%
SAMSUNG	79%	89%	80%	88%	81%	86%	95%	86%
NOKIA	80%	84%	89%	90%	86%	79%	92%	86%
MOTOROLA	74%	88%	91%	92%	84%	78%	94%	86%
XIAOMI	77%	87%	90%	83%	85%	83%	89%	85%



BEST SMARTWATCH MANUFACTURER

WINNER XIAOMI

HIGHLY COMMENDED APPLE, GARMIN

Let's not beat about the bush here: Xiaomi wins the Best Smartwatch Manufacturer award for one key factor: value. Michael Crooks described this succinctly as "excellent", while Paul Vincent said his was a "good budget smart band [that] tracks

everything I need and the battery life is approximately one week with heart-rate monitor on auto". And Xiaomi's battery life results – together with 97% of people saying they would buy a Xiaomi smartwatch again – are another key reason for its victory.

Apple, on the other hand, lost its top position due to the relatively poor perception of its

	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	BATTERY LIFE	EASE OF USE	BUY AGAIN?	OVERALL
XIAOMI	79%	89%	91%	88%	85%	97%	88%
APPLE	89%	92%	78%	75%	90%	93%	86%
GARMIN	80%	90%	85%	87%	81%	94%	86%
HUAWEI	72%	82%	90%	89%	80%	86%	83%
SAMSUNG	82%	90%	81%	71%	87%	88%	83%
FITBIT	68%	78%	75%	74%	80%	77%	75%



watches' battery life. "The battery life is much shorter than my wife's Huawei and yet they do much the same job," said Liam McQuade. However, Paul Taylor-Bell described his Watch Ultra as a "life-changing device", and others praised its excellent integration with other Apple devices.

Garmin once again performed well in our survey, with Mark Matthews' response perhaps explaining why it remains near the top – but not quite at the peak. "It's great for recording my sporting activities, but does not have the general features of most smartwatches."

BEST PRINTER MANUFACTURER

WINNERS BROTHER, XEROX

Brother has had its name printed on this award for more than a decade now, but this year it's been forced to share the spoils with Xerox.

Brother is renowned for its reliability. The Verge infamously writes a printer roundup that contains the same advice every year: just buy the Brother printer that everyone else does. And with a 91% reliability score, you can see why people stick with the brand.

But Xerox pips it in our survey for both customer support and print quality, meaning the pair will have to take home a gong each, with both landing overall scores of 90%.

	CUSTOMER SUPPORT	RELIABILITY	VALUE INC RUNNING COSTS	PRINT QUALITY	BUY AGAIN?	OVERALL
BROTHER	81%	91%	89%	90%	98%	90%
XEROX	86%	90%	86%	93%	97%	90%
EPSON	80%	88%	85%	88%	93%	87%
CANON	76%	84%	81%	86%	94%	84%
HP	73%	78%	77%	84%	83%	79%

John Sinclair is on his third Brother printer and says he has "always been satisfied" with the brand. Stuart Dearing backs him up, adding that his Brother "has not let me down" and is "cheaper to run" than its predecessor.

Tsz Him Chung, meanwhile, is a big fan of his Xerox B225 mono laser. "The print quality is sharp and the speed is impressive, even

for larger documents," he reports. Others commented on the superb print quality, though a few gripes about consumable prices may explain why Xerox dipped below Brother in the value for money category.



BEST MONITOR MANUFACTURER

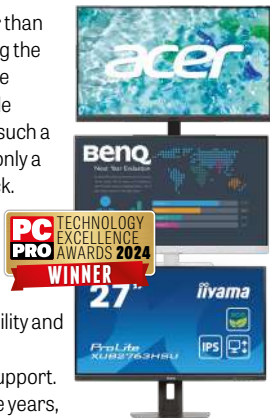
WINNERS ACER, BENQ, IIYAMA

Categories don't come much tighter than this one, with four points separating the award winner from the unfortunate Samsung, which sits bottom of the table despite decent scores. In fact, we had such a tight race that our joint winners were only a razor's width ahead of the chasing pack.

Our three winners each had different factors propelling them to the top. For Acer, it was the 98% of customers who said they would buy again. BenQ topped the table for reliability and image quality, while Iiyama won for its all-round consistency and customer support.

This consistency stretches over the years, with Iiyama also earning the crown in 2023.

"I have owned a succession of Iiyama monitors from the days of CRTs and have never been disappointed by their quality or reliability," said Nik Whiddett. "The only reason I have replaced monitors is to trade up to a significantly better spec."



	CUSTOMER SUPPORT	RELIABILITY	VALUE FOR MONEY	IMAGE QUALITY	BUY AGAIN?	OVERALL
IYYAMA	85%	91%	90%	89%	96%	90%
BENQ	79%	93%	92%	93%	95%	90%
ACER	83%	91%	88%	90%	98%	90%
HP	82%	91%	90%	92%	94%	89%
DELL	80%	91%	89%	91%	96%	89%
MSI	84%	90%	90%	90%	93%	89%
LG	80%	89%	87%	93%	96%	89%
ASUS	74%	89%	85%	92%	95%	87%
AOC	76%	90%	91%	89%	89%	87%
SAMSUNG	77%	90%	83%	87%	92%	86%

To soften the blow of finishing bottom for Samsung, it's worth pointing out that the vast majority of commenters were satisfied with their screen. "Excellent monitor for way under £800," said Steven Fletcher. "Crisp picture, bright whites and deep blacks. Plus comes with Smart TV, Amazon Alexa and a great remote."



PRODUCTS OF THE YEAR

Out of the hundreds of products we reviewed in the past 12 months, these are the handful that stand out as the best – plus our choices for technology and sustainability innovation



LAPTOP OF THE YEAR

WINNER ASUS ZENBOOK S 14 OLED **HIGHLY COMMENDED** ASUS PROART PX13

It's a double win for Asus this year, as it relentlessly hammers out great designs based on the latest CPUs. "The ZenBook S 14 OLED was the first I tested to use Intel's second-gen Core Ultra chips," said editor-in-chief Tim Danton, "and if this is a sign to come then we're in for a treat in 2025. Super-slim, stylish and staggering battery life for an OLED laptop." And Asus once again delivered for AMD and its Ryzen HX 300 chips, extracting amazing amounts of power from the CPU to create a creative 13in workhorse in the ProArt PX13.



DESKTOP PC OF THE YEAR

WINNER CYBERPOWERPC ULTRA R77 RTX
HIGHLY COMMENDED GEEKOM A8

We can always trust CyberPowerPC to deliver high-quality, high-value PCs based around the latest tech, and this year it was the combo of AMD's gaming-focused Ryzen 7 7800X3D and an Nvidia RTX 4080 Super that claimed top prize. "Plus I loved the angles of the NZXT H6 Flow chassis," said editor-in-chief Tim Danton. And while the Gekom A8 can't match the Minisforum Venus UM790 Pro for value in our mini PC Labs (see p78), it remains a fantastic choice for power in a tiny package.

BEST BUSINESS SOFTWARE

WINNER 3CX V20
HIGHLY COMMENDED VERITAS BACKUP EXEC 23

3CX keeps on winning our Best Business Software award, and that's because Dave Mitchell continues to be wowed by it. "Whether it's on-premises or cloud-hosted, 3CX's affordable Phone System 20 is the perfect solution for businesses that want total control over their VoIP services," he said, adding that he was particularly

impressed by its "smart new admin console". This year it was pushed close by Veritas Backup Exec 23, with Dave explaining that "the new anomaly detection and malware scan features provide essential ransomware protection, and Veritas' Simple Core Pack subscriptions will appeal hugely to SMBs".

SECURITY PRODUCT OF THE YEAR

WINNER WITHSECURE ELEMENTS ENDPOINT SECURITY
HIGHLY COMMENDED WATCHGUARD FIREBOX M390

Along with its A List award this month (see p101), WithSecure claims our Security Product of the Year gong. "I really liked its proactive threat detection and automated remediation features, the new Luminen AI-based tool that adds valuable assistance in times of need, and an early release programme that allows you to test client software updates before going live," said Dave Mitchell. Why the Firebox? "It provides an exceptional range of protection services that are easily managed on-premises or from a cloud portal – I use WatchGuard to front my testing lab for these very reasons."



WORKSTATION OF THE YEAR

WINNER ARMARI MAGNETAR MC64T7-AW1650G4
HIGHLY COMMENDED SCAN 3XS GWP A1-TR64

We'll leave it to workstation specialist James Morris to explain why these two power-soaked systems gain this year's awards. "The non-Pro AMD Ryzen Threadripper is back with a vengeance with the 64-core 7980X," said James, "and the Armari showcases what this CPU can do, providing the best all-round workstation performance I have ever seen." Meanwhile, the Scan delivers "superb rendering performance and real-time graphics", while its Threadripper 7970X and Nvidia TRX 5000 graphics "balance high-end workstation capabilities perfectly".





BEST PHONE

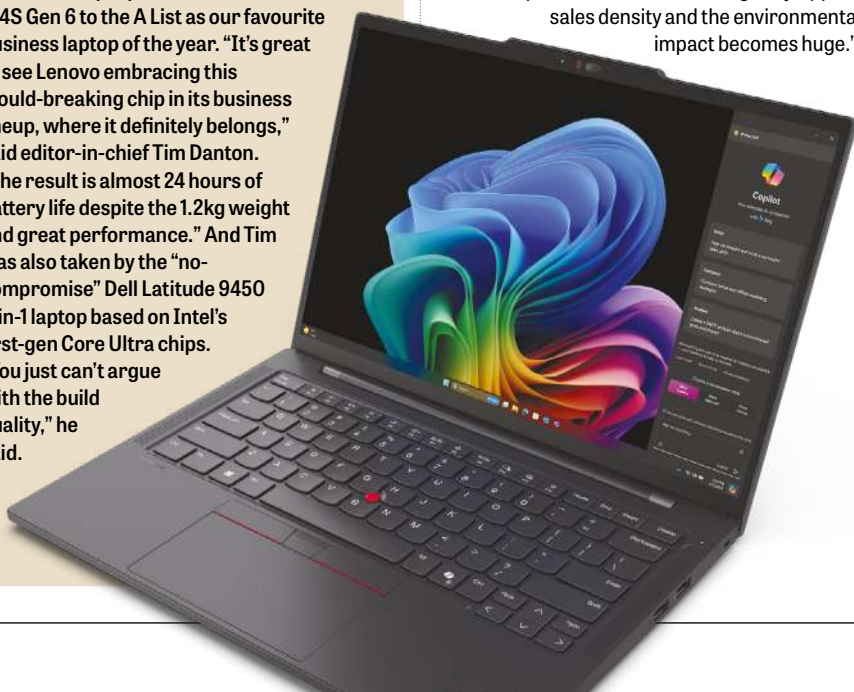
WINNER HONOR MAGIC V3
HIGHLY COMMENDED MOTOROLA RAZR 50 ULTRA

Last year the 9.9mm-thick Honor Magic V2 won our Technology Innovation of the Year, but the Magic V3 is even better: slimmer, at 9.2mm, but also packing an excellent camera with a 5x optical zoom and Qualcomm's latest Snapdragon 8 Gen 3 SoC. "It was a sad day when I packed it up in its box to return to Honor," said editor-in-chief Tim Danton, describing it as "the first foldable I'd recommend to anyone as a day-to-day phone". And sticking on the bendy theme, the flippable Razr 50 Ultra earned its Highly Commended award for "compact power and such a desirable design, all without costing a fortune".

BEST BUSINESS LAPTOP

WINNER LENOVO THINKPAD T14S GEN 6
HIGHLY COMMENDED DELL LATITUDE 9450 2-IN-1

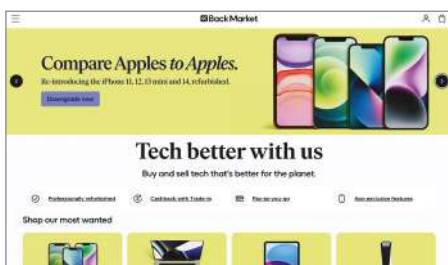
We couldn't let 2024 pass without some glory going to Qualcomm for its Snapdragon chips, one of which propelled the Lenovo ThinkPad T14S Gen 6 to the A List as our favourite business laptop of the year. "It's great to see Lenovo embracing this mould-breaking chip in its business lineup, where it definitely belongs," said editor-in-chief Tim Danton. "The result is almost 24 hours of battery life despite the 1.2kg weight and great performance." And Tim was also taken by the "no-compromise" Dell Latitude 9450 2-in-1 laptop based on Intel's first-gen Core Ultra chips. "You just can't argue with the build quality," he said.



INNOVATION OF THE YEAR

WINNER INTEL CORE ULTRA 200V SERIES
HIGHLY COMMENDED APPLE VISION PRO

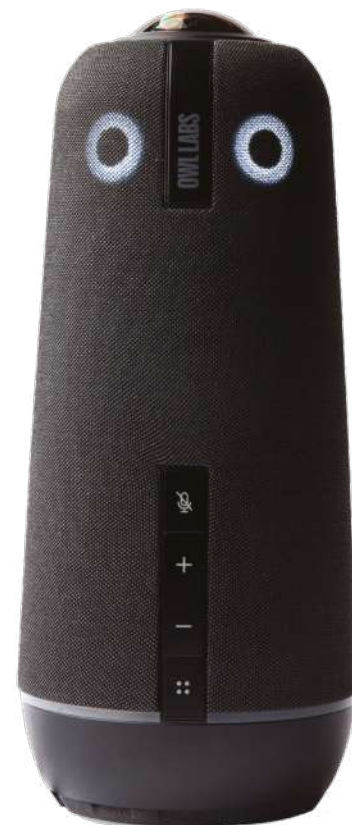
The Core Ultra 200V series is the power behind the throne of Asus' award-winning Zenbook S 14 OLED opposite and a winner in its own right here. "I can't speak highly enough of what Intel has done to deliver performance-per-watt that comes so close to Qualcomm's Elite chips," said editor-in-chief Tim Danton. "If this carries on, we might finally be able to forget about battery life in laptops." And Jon Honeyball praised the Vision Pro for "finally delivering what augmented reality headsets should always have been".



SUSTAINABILITY EXCELLENCE AWARD

WINNER BACK MARKET
HIGHLY COMMENDED APPLE

"Back Market's ambition to normalise not-new purchasing is vital to a circular economy," said Lee Grant, when arguing why it should win this award. "And its Innovation Lab breaks down barriers to refurbishment then shares the knowledge with vendors, keeping tech working for longer." And the surprise package, Apple? "For the battery inside the iPhone 16s," he said. "Apple batteries now have 95% recycled lithium along with 100% recycled cobalt. Also, it's now enclosed in recyclable aluminium instead of plastic. Scale these changes by Apple's sales density and the environmental impact becomes huge."



BUSINESS HARDWARE OF THE YEAR

WINNER MEETING OWL 4+
HIGHLY COMMENDED DRAYTEK VIGOR 2927LAX-5G

Dave Mitchell reviews 50 business hardware products for us each year, but the Owl 4+ stands out for its "all-seeing 4K eye". He also loved its "clever 360° panoramic and dynamic split-screen views, smooth speaker tracking and super sound quality". The DrayTek Vigor 2927Lax-5G earns its award for not only its "top" value for money but also "an incredible range of WAN failover features, being super simple to manage and even including integral Wi-Fi 6 services". Just missing the cut? TP-Link's Omada EAP783, the first Wi-Fi 7 access point to earn a PC Pro Recommended award. ●

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A large, stylized illustration of a raspberry serves as the background. It features two green leaves at the top with serrated edges and a central cluster of red, oval-shaped drupelets. The entire graphic is outlined in black.

RASPBERRY PI

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WHICH BOARD IS RIGHT FOR YOU?

.....

THE POPULAR HOBBYIST BOARD COMES IN MANY VARIANTS.
NIK RAWLINSON DEMYSTIFIES THE LINEUP

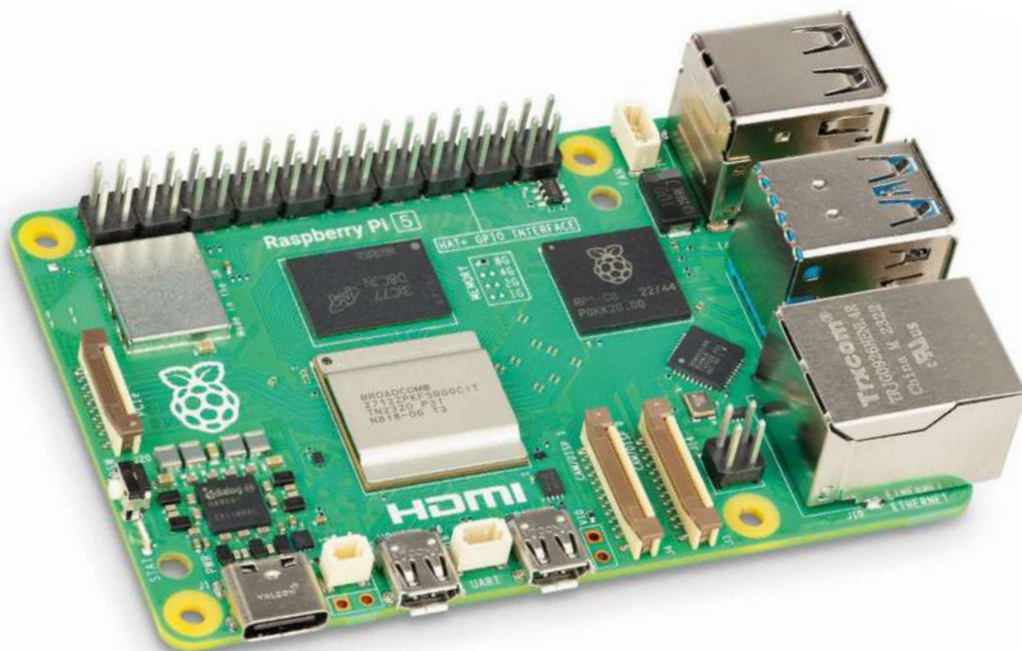
The Raspberry Pi is the best-selling British personal computer of all time. Launched in 2012, it surpassed the ZX Spectrum's lifetime sales in just three years, and it's remained on an upward trajectory ever since.

The platform has also expanded considerably. There are now five major generations of the Raspberry Pi, plus compact Zero variants and the ultra-lightweight Raspberry Pi Pico microcontroller board – not to mention

a wide range of peripherals, including keyboards, mice, cameras, touch displays and much more.

While it's great to have so many options, it can be also be a bit daunting. If you're new to the world of Raspberry Pi, you could be forgiven for not knowing where to start. Do you need a full-sized board? How much processor power do you need, and how much RAM? And how can you get the right connectors for your needs?

In general, if you're looking for a general-purpose hobbyist computer then a full-sized board is likely to be your best bet, while the Zero range serves admirably for basic Python projects, and the Pico is a very cheap and simple platform for embedded roles. But it's not always clear-cut; everything depends on what you want to build and how you plan on using your board in the long term. Here's our guide to the most popular Raspberry Pi models, to help you tell them apart and pick the right one.



RASPBERRY PI 5

Price £47 (2GB), £58 (4GB), £77 (8GB)

Processor 2.4GHz quad-core 64-bit ARM Cortex-A76

Wireless support Dual-band 802.11ac Wi-Fi and Bluetooth 5.0

Ethernet Gigabit Ethernet with PoE+ support (requires separate PoE+ HAT)

Video Dual 4K micro-HDMI outputs

Storage High-speed microSD card slot

USB 2 x USB 3.2 Gen 1 ports; 2 x USB 2 ports

Connectivity 2 x 4-lane MIPI camera / display transceivers; Raspberry Pi standard 40-pin GPIO header

Launched in September 2023, the Raspberry Pi 5 is the latest, most powerful and versatile Raspberry Pi model. That might not be immediately obvious from looking at it, though: it has broadly the same appearance as its predecessors, and sports the standard Raspberry Pi 40-pin GPIO connector, used to interface with peripherals and sensors.

All the same, the Raspberry Pi 5 brings significant changes and improvements to the platform. The processor has a new core and faster clock speeds than the one that drives

the Raspberry Pi 4, helping not only to boost speed but also to reduce power consumption. In contrast to the design of Pi 4 and earlier boards, many of the I/O subsystems have been offloaded to a separate controller, which sits along another spin-off chip that handles power management.

The connectors are different, too. The 3.5mm audio jack of earlier models is gone, and there are changes to the camera and display interfaces, which now let you connect a pair of cameras or screens in addition to the two HDMI outputs. There's also a power switch (a first for Raspberry Pi) and an FPC connector allowing for a single-lane PCI Express 2.0 connection.

This last feature is a real boon for anyone who's looking to use Raspberry Pi 5 as the basis of a desktop replacement computer, as it can be used to connect fast external storage. We've paired it with the optional £11.50 M.2 HAT+ (see p42) to mount a huge 1TB NVMe SSD as our system drive, making the Pi boot up and load apps in a flash.

There are just two catches. One is that, thanks to its higher speeds, the Raspberry Pi 5 may run hotter than the Pi 4 – if you want to drive it hard,

ABOVE The Raspberry Pi 5 is the latest and most powerful model

RASPBERRY PI 4

Price £34 (1GB), £43 (2GB), £53 (4GB), £72 (8GB)

Processor 1.5GHz quad-core 64-bit ARM Cortex-A72

Wireless support Dual-band 802.11ac Wi-Fi 5 and Bluetooth 5

Ethernet Gigabit Ethernet with PoE+ support (requires separate PoE+ HAT)

Video Dual 4K micro-HDMI outputs

Storage High-speed microSD card slot

USB 2 x USB 3.2 Gen 1 ports; 2 x USB 2 ports

Connectivity Camera connector; display connector; Raspberry Pi standard 40-pin GPIO header

BELOW The Pi 4 is five years old, but is still a great choice for certain projects



All prices include VAT



Originally released in 2019, the Raspberry Pi 4 is still a formidable board. It was the first Pi model to be offered in an 8GB variant, and the first to be powered over USB-C, which provides enough power to max out the CPU and drive a full array of peripherals – although if you work the processor hard you’ll also need some means of cooling to avoid thermal throttling.

The Pi 4 has a lot in common with the Pi 5: it has four USB ports (two of which support SuperSpeed USB 3.2 Gen 1 connections), gigabit Ethernet and support for driving two displays at up to 4K. It’s hardware-compatible with most other models, and uses the same 40-pin GPIO header for direct connection of compatible peripherals. Although the Pi 4 lacks the PCI Express 2.0 connection of the Pi 5, you can still configure it to use an external USB drive to boot, launch applications, and host data.

The 2GB, 4GB and 8GB versions of the Pi 4 are priced almost identically to the corresponding Pi 5 versions, so it’s probably not the best choice for a general-purpose Pi. However, there’s also a 1GB version of the Pi 4, which could be a great low-cost choice for projects with lighter hardware requirements – and although the Pi 4 is now five years old, you don’t need to worry about the board going out of support for at least another decade (see “Older Raspberry Pi models”, p42).

RASPBERRY PI 400

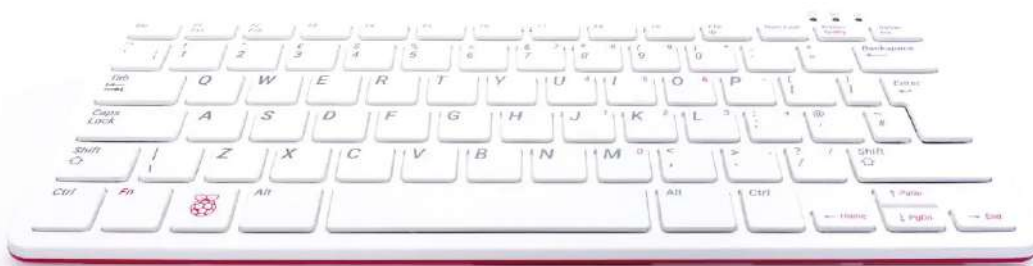
Price £79 (4GB)

Processor 1.8GHz quad-core 64-bit ARM Cortex-A72

Wireless support Dual band 802.11ac Wi-Fi and Bluetooth 5.0

Ethernet Gigabit Ethernet

Video Dual 4K micro-HDMI outputs



Storage High-speed microSD card slot

USB 2 x USB 3.2 Gen 1 ports; 1 x USB 2 port

Connectivity Raspberry Pi standard 40-pin GPIO header

While other Pi models are sold as bare boards, the Pi 400 has a unique design with an integrated keyboard, reminiscent of classic home computers. Just plug in a mouse and you’re ready to go.

In terms of technology, the Pi 400 is very similar to the Raspberry Pi 4, although it’s only offered in a standard 4GB RAM configuration and its processor runs 20% faster, at 1.8GHz. There’s no need to add a cooler, as the chassis has one built in.

Despite the all-in-one form factor, the Pi 400 still has accessible GPIO pins, so you can use it with all the same projects and peripherals as other models. In this case, though, they’re situated on the side of the board, so you may want to spend a few quid on a GPIO extension cable.

If you’re looking for a neat, all-in-one machine for occasional desktop tasks the Pi 400 is an attractive proposition, and at £79 it’s very reasonably priced, too. However, it’s overkill for basic projects, while for everyday productivity its performance lags behind the Raspberry Pi 5 – we’re hoping that an upgraded Pi 500 model might be along soon. If you do decide to invest in a Pi 400, you should also

ABOVE The Pi 400 has a built-in keyboard as well as the usual GPIO pins

take care to buy one with the right keyboard layout, as regional variants are offered with layouts for the UK, US, France, Germany, Italy and Spain.

RASPBERRY PI ZERO 2 W

Price £16 (512MB)

Processor 1GHz quad-core 64-bit ARM Cortex-A53

Wireless support Dual band 802.11 b/g/n Wi-Fi and Bluetooth 4.2

Ethernet N/A

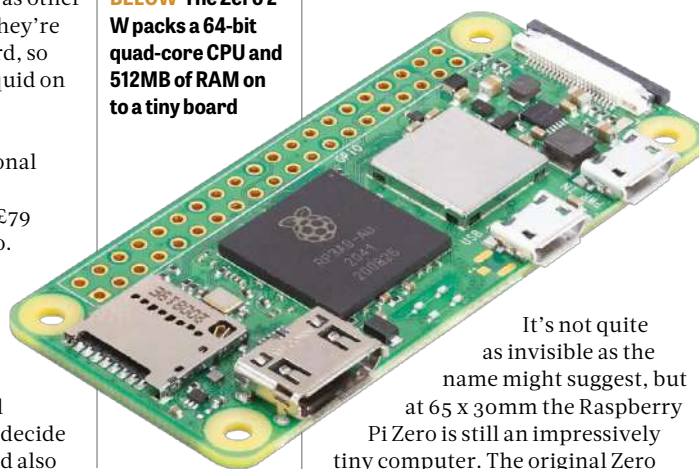
Video Mini HDMI

Storage High-speed microSD card slot

USB 2 x micro-USB (of which one is used for power)

Connectivity Raspberry Pi standard 40-pin GPIO header

BELOW The Zero 2 W packs a 64-bit quad-core CPU and 512MB of RAM on a tiny board



It’s not quite as invisible as the name might suggest, but at 65 x 30mm the Raspberry Pi Zero is still an impressively tiny computer. The original Zero board, launched in 2012, is still available, but we’d recommend you look to the newer Zero 2 W, which offers a far more powerful and versatile hardware specification with the same tiny footprint.

That includes a 64-bit quad-core processor and 512MB of RAM, a single micro-USB data port (the second port is used only for power) and a mini-HDMI video output. As the “W” in its name indicates, it also includes onboard wireless networking – so if you wanted, you could simply plug in a keyboard, mouse and display and use it as a regular computer.

The Zero 2 W makes more sense, though, when set up as a headless device, for running network services or hosting sensors. If you’re interested in that latter role, however, be aware that, by default, the Zero 2 W comes

RASPBERRIES ARE NOT THE ONLY FRUIT – INTRODUCING THE PIMORONI PICO PLUS 2 W

As well as making its own boards, Raspberry Pi has recently started supplying its RP2350 processors to third parties, opening the door to new variations on the Pico format. The first such product to arrive is the Pimoroni Pico Plus 2 W (tinyurl.com/363pimoroni) – a board that’s the same size as the Raspberry Pi Pico and Pico 2, and fully compatible with its code and peripherals, but with some useful extra features. In place of the Pico’s outdated micro-USB connector, it uses a USB Type-C connection for power and programming, and comes with a much more generous 8GB of RAM and 16GB of flash storage. Most importantly, it also features onboard Bluetooth and Wi-Fi.

This makes the Pimoroni Pico Plus 2 W an ideal choice for simple networked tasks, such as remotely logging incoming information. At £16.80 it’s quite a bit pricier than a regular Pico, but still very affordable. Just note that, like the official Pico 2, it comes without GPIO pins; you can add these for another 96p, but you’ll need to solder them on yourself.



without GPIO pins – just a set of mounting holes. If you're comfortable with a soldering iron, you can buy a suitable set of pins for around £1.50 and install them yourself; alternatively, Pimoroni offers a so-called Hammer Header, which is a set of pins that can be bashed smartly in the board with a few well-directed strikes; we recommend you also buy the optional jig that guides them into the holes on the board while protecting the board from your hammer, for a total cost of £7.20.

A final option is to order the Raspberry Pi Zero 2 WH variant – note the additional "H" – which comes with a pre-soldered header. Be warned, though, there is a price premium for the WH edition: it costs 66p more than the standard model.

RASPBERRY PI PICO 2

Price	£4.80 (520KB)
Processor	RP2350 processor running at 150MHz
Wireless support	N/A
Ethernet	N/A
Video	N/A
Storage	4MB flash memory
USB	1 x micro-USB for power and setup
Connectivity	Dual banks of GPIO pin connectors

Not everything needs to run on a general-purpose computer. Some tasks just require a little bit of brainpower – and that's where the Raspberry Pi Pico comes in. Based on a microcontroller, rather than a full-spec CPU, the Pico board is ideal for simple, repetitive roles such as timers, security systems and robotics controllers.

As with the Zero, the original Pico is now quite ancient; the much newer Pico 2, released just a few months ago, brings a faster processor and double the memory of the original device (meaning you now get an enormous 520 kilobytes of RAM). Unusually, the RP2350 chip lets you choose whether

GETTING KITTED OUT

WHERE CAN I BUY MY PI?

Raspberry Pi doesn't sell directly to the public, but there are several authorised retailers online, such as Pimoroni (pimoroni.com) and The Pi Hut (thepihut.com). While they all sell the main Pi boards, their prices can differ slightly, and they offer different ranges of third-party accessories, so it's worth shopping around.

DO I NEED TO BUY A POWER SUPPLY?

Raspberry Pi produces its own range of power adaptors, but since the boards are powered by standard USB connectors you may already own a suitable power supply. Note that the newer models (which use USB Type-C power connectors) have particular power requirements: the official Raspberry Pi 4 power supply is rated at 15W, while the Pi 5 one is rated at 27W.

DO I NEED TO PLUG IN A KEYBOARD, MONITOR AND MOUSE?

Not necessarily – we run the majority of our Raspberry Pi devices "headless", and access them entirely over the network. If you set up your



ABOVE Pi boards are powered by standard USB connectors

microSD card using the Raspberry Pi Imager tool (available for Windows, Linux, and macOS at raspberrypi.com/software), you can preconfigure SSH and network access, and connect to your Pi as soon as it boots up. If you need access to the GUI and you've installed a 64-bit version of Raspberry Pi OS, you can also log in through a web browser by visiting connect.raspberrypi.com on the machine from which you want to control it.

If you prefer to use your Pi in desktop mode, that's easy too.

Raspberry Pi 5 and 4 boards have four full-sized USB adapters for peripherals, and two micro-HDMI ports for monitor connections.

Raspberry Pi Zero and Zero 2 variants have a single available micro-USB port and one mini HDMI, and all Pi models with Wi-Fi can also support Bluetooth keyboards and mice.

CAN I RUN WINDOWS ON THE PI?

It is technically possible to install the Arm version of Windows 11 on a

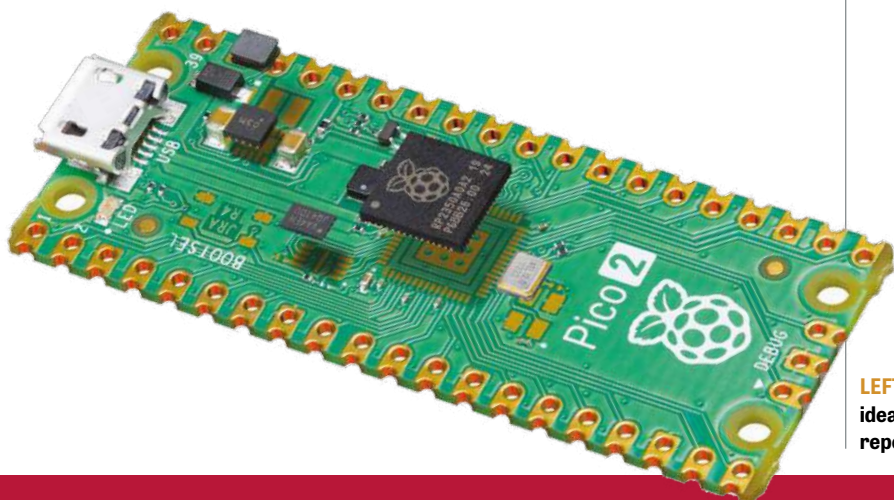
Raspberry Pi – but it involves some tinkering, it's definitely not supported, and you may not be delighted with its performance. If for any reason the official Raspberry Pi OS isn't working for you, we'd recommend seeking out an alternative flavour of Linux, or a bespoke environment such as Diet Pi or LibreELEC.

to use a pair of industry-standard Cortex-M33 cores or open-hardware Hazard3 RISC-V cores, depending on your preferences and interests. The board also offers two rows of GPIO sockets, to which you can solder pins for attaching external sensors and peripherals in the same way as larger Pi boards, although the connection isn't identical.

Owing to its limited hardware, the Pico doesn't run a full desktop OS, so the experience of using it is quite different to a regular Pi: you create your code on a host device, in

C, C++ or Python, then connect the Pico to the host via USB and transfer the code for it to run.

It's also important to note that the Pico 2 also lacks Wi-Fi and Bluetooth connectivity. These may be added in a future revision, as they were to the original Pico; in the meantime, if you have a microcontroller project that relies on a network connection, check out the Pimoroni Pico Plus 2 W (see opposite).



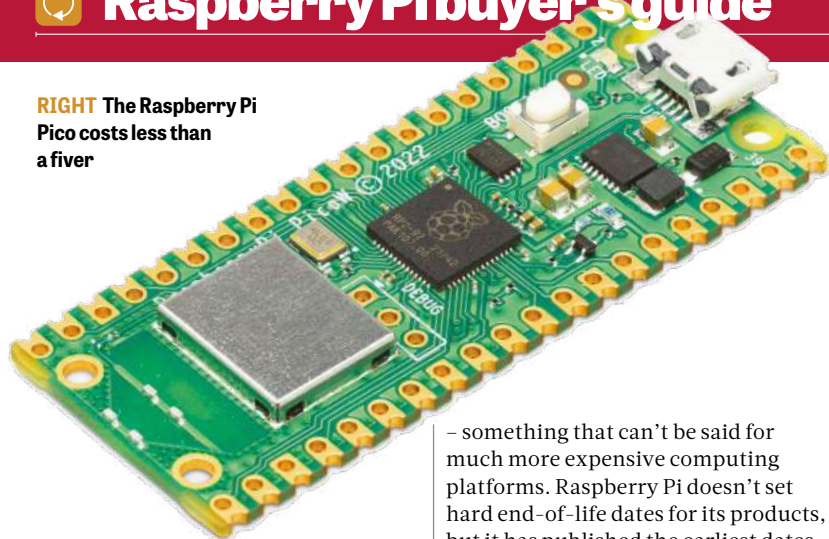
LEFT The Pico 2 is ideal for simple, repetitive tasks

PICO, PICO W AND PICO WH

Price	£3.80 (Pico, 264KB), £4.80 (Pico W, 264KB), £6.80 (Pico WH, 264KB)
Processor	RP2040 processor running at 133MHz
Wireless support	N/A on Pico / Wi-Fi and Bluetooth on W and WH variants
Ethernet	N/A
Video	N/A
Storage	2MB flash memory
USB	1 x micro-USB for power and data transfer
Connectivity	Dual banks of GPIO pin connectors

Raspberry Pi buyer's guide

RIGHT The Raspberry Pi Pico costs less than a fiver



The first-edition Raspberry Pi Pico is the very cheapest Pi board you can get. Built on Raspberry Pi's RP2040 processor, with 2MB of flash storage and 264KB of SRAM, it costs under a fiver even for the version with integrated Wi-Fi, although the WH version that comes with GPIO headers pre-fitted pushes the price up to nearly seven pounds.

To be honest, there's not much reason to choose the regular Pico these days. While it will still be supported until 2036, you'll get a much more versatile board if you pay the extra pound for the Pico 2, or opt for Pimoroni's more tricked-out model. However, the inclusion of Wi-Fi and Bluetooth make the original Pico W and WH a great dirt-cheap starting point for any project that needs to communicate with the outside world, such as crunching small packets of data from an API or notifying you of potential intruders as part of a homebrew security system.

OLDER RASPBERRY PI MODELS

One of the great things about Raspberry Pi is long-term support. Whatever project you're working on, it's good to know that the hardware and software will remain available and supported for many years to come

– something that can't be said for much more expensive computing platforms. Raspberry Pi doesn't set hard end-of-life dates for its products, but it has published the earliest dates at which production may be stopped for the latest generation of each board:

Raspberry Pi 2 / 400 January 2026

Raspberry Pi 3 January 2028

Raspberry Pi 1 / Zero / Zero W / Zero 2 W January 2030

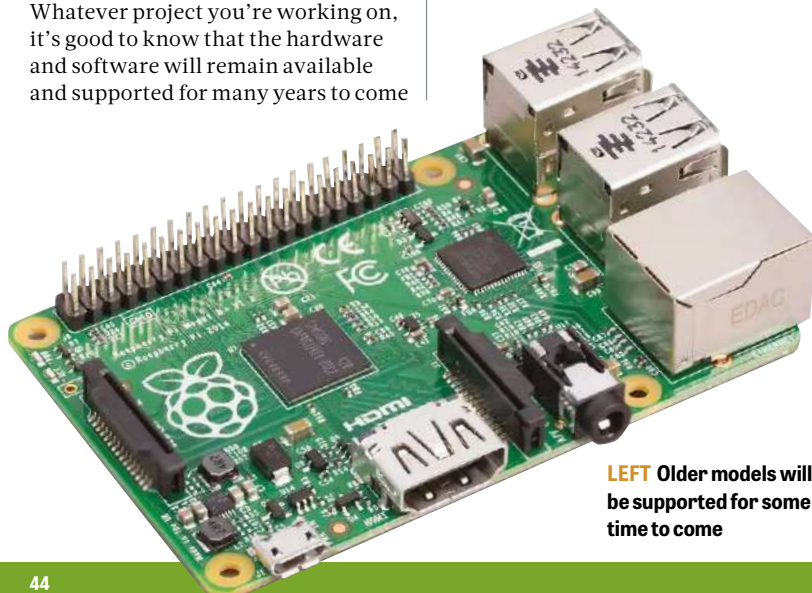
Raspberry Pi 4 January 2034

Raspberry Pi 5 / Pico / Pico W / Pico WH January 2036

Raspberry Pi Pico 2 January 2040

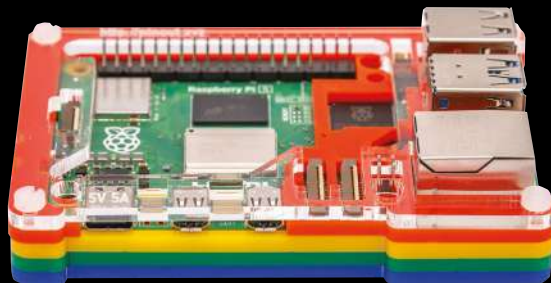
Despite the long shelf-life of the hardware, we wouldn't recommend buying an older Pi board today. The price saving is small, and earlier models not only have less powerful processors, they may have design restrictions such as only two USB connectors – and there's no Wi-Fi on models released before 2016.

Even when replacing an existing Pi, it's normally worth taking the opportunity to move up to a later model – you'll probably need a fresh OS installation to get the right support for the updated hardware, but any projects you've created yourself should carry on working without modification. Just remember that the latest Raspberry Pi 5 boards have a slightly different physical layout to earlier models, so enclosures and coolers designed for the previous versions won't fit. ●



LEFT Older models will be supported for some time to come

OUR TOP 5 RASPBERRY PI ADD-ONS



PIBOW COUPE CASE FOR RASPBERRY PI 3, 4, 5

PRICE £7.20 from tinyurl.com/363coupe

These colourful cases comprise several layers of transparent plastic, with convenient holes for heatsinks and fans if required.

RASPBERRY PI TOUCH DISPLAY

PRICE £58 from tinyurl.com/363touch

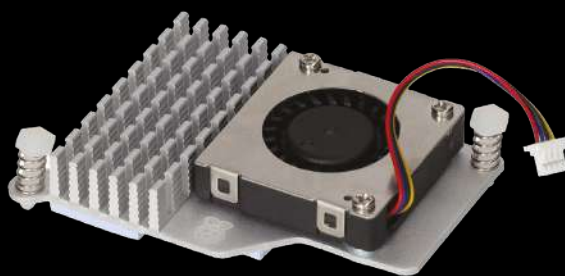
This touch-sensitive 7in screen has an 800 x 480 resolution and makes use of Raspberry Pi OS's built-in drivers for ten-finger touch and onscreen keyboards. (Requires an adapter cable for connection to Raspberry Pi 5.)

M.2 HAT+

PRICE £11.50 from tinyurl.com/363hat

Upgrade your Raspberry Pi 5 with support for M.2 peripherals, including NVMe drives. (Won't work with earlier boards.)

ACTIVE COOLER FOR RASPBERRY PI 5



PRICE £4.90 from tinyurl.com/363active

Avoid throttling by cooling your board in day-to-day use.

RASPBERRY PI CAMERA MODULE 3

PRICE £26 from tinyurl.com/363camera

Available in regular and wide-angle versions, with or without IR filters, this 12-megapixel camera can sit at the heart of an enormous number of projects. (Comes with a standard cable; separate cable required for use with Raspberry Pi 5 or Zero.)



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■ pcpro.link/norton360

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Norton Parental Control provides tools to see exactly what your kids are up to on their various devices, and you also get GPS location monitoring for Android and iOS.

To round things off, Norton Password Manager generates and stores passwords across all your devices, while SafeCam for PC stops cybercriminals attempting to take photos with your webcam without your knowledge.

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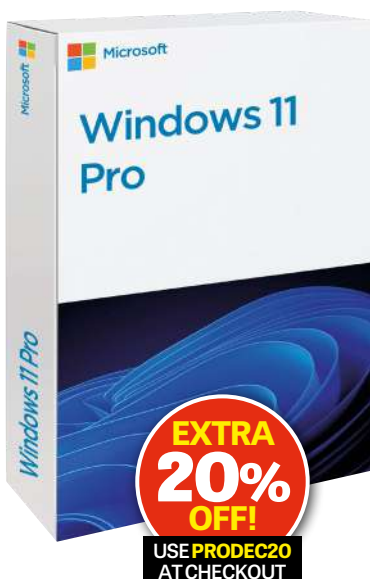
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The first reason is simple: price. Microsoft charges £119.99 for a retail licence of Windows 11 Home, and a staggering £219.99 for Windows 11 Professional. By choosing an OEM licence – and avoiding the many dubious sources of licences you may find online – you cut that price substantially.



ALSO CONSIDER Windows 11 Home for £59.99 **SAVE 50%**

Acronis True Image 2025 Advanced for £29.99 (one PC or Mac, one-year licence)

■ tinyurl.com/362acronis

Acronis' one-stop security shop combines a full backup suite with comprehensive anti-malware protection.

It offers the full gamut of backup options, from individual files to complete drive imaging, active disk cloning and support for cloud-hosted backups. There's also an Archive option for offloading larger files to the cloud, a Sync tool and a host of additional tools, including system clean-up and drive-scrubbing tools, Acronis Secure Zone (an encrypted partition for storing sensitive files), and Acronis Universal Restore (a tool for migrating all your apps, documents and settings to a new PC).

Acronis True Image is simple to use, with plenty of advanced tuning available to those who want full control over their system.

The Advanced package improves on Essentials by offering 50GB of cloud storage. You can still back up to local disks, network attached storage or remote destinations via FTP. You can also backup Microsoft 365 data.



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PICK THE PERFECT STYLUS

There's nothing quite like the intuitive, tactile experience of a digital stylus. **Darien Graham-Smith** explores the technology, and how to pick the best stylus for your needs



ABOVE Devices with an active stylus can detect the pen even when it's hovering above the display

If you don't regularly use a computer stylus, you might imagine they're only relevant to artists – an impression reinforced by the fact that they're often sold as optional add-ons to tablets, rather than essential components.

But try one out and you might well find that the stylus is a transformative way to interact with a computing device, especially a tablet. Holding it in your hand, like a pen, is much more comfortable than prodding and swiping on a hard glass screen with your fingers and thumb – and it allows you to be far more precise in your interactions, so it's particularly handy for apps with lots of buttons, or tapping in text on a small-scale virtual keyboard.

Needless to say, though, you don't have to use that keyboard – you can use the stylus to handwrite directly onto the screen. Today's handwriting-recognition systems have come a long way since the much-ridiculed Apple Newton (see “*Never out of style*”, p46); a tablet can instantly convert your scrawl into text with eerie accuracy, and things will probably only get better as AI is increasingly brought into play.

That's assuming you want to have your writing converted, of course. If you're making notes for your own

reference or annotating an existing document, you may prefer to leave your notes in handwritten form – behind-the-scenes text recognition can still make it searchable and indexable. You can also use the stylus to cross out and highlight bits of text or make marginal sketches, and share them with others.

And while it may seem like a small, silly thing, it's also pleasing to note that a stylus won't leave greasy smudges on your screen and cheapen the appearance of your shiny, sexy tablet.

Different types of stylus

There are three main types of stylus: resistive, capacitive and active. The first type is largely obsolete these days, and that's a good thing. Resistive styluses work with old-fashioned resistive touchscreens, which register touch by detecting when two membranes built into the display are physically pushed together. The stylus itself is nothing more than a little handheld stick that presses down at the desired location; you could use anything with a pointed end to do the job, including a finger if you're not too worried about precision.

Capacitive styluses aren't much smarter, but they're designed to work with modern touchscreen displays,

ABOVE A stylus is not just for digital artists – it can be great for taking notes, for example

using a conductive tip that allows the device to detect its presence and location electrically, in the same way as a human finger. In fact, the screen can't tell the difference between a finger and a passive stylus; this conveniently means that any passive stylus can be used with almost any touchscreen device, without needing to worry about compatibility or specific support. Since the stylus doesn't need to be powered, it can also be very thin, light and cheap – and, of course, it never needs recharging. The downside is that a capacitive stylus can't support “smart” features: it registers touch and nothing else.

Active styluses are the most sophisticated.

Devices that work with an active stylus have additional sensing hardware that can detect the pen even when it's hovering above the display. They can also receive input messages from the stylus, such as button presses or squeezes, via either Bluetooth or a proprietary connection system. ➤

Try one out and you might well find that the stylus is a transformative way to interact with a computing device



Many active styluses have built-in sensors, too. A pressure sensor built into the nib of the stylus can tell the host device how hard the user is pushing down, enabling the OS or apps to implement pressure-sensitive features; for example, if you're sketching, the stylus can simulate a pencil by making the line thicker and darker the harder you press. Internal accelerometers allow the stylus to detect tilting or twisting, or "air gestures", where waving the stylus in a certain way sends a command to the host device.

Because an active stylus doesn't rely solely on capacitance, the host device can also tell the difference between the nib and a human body part, and you can freely rest your drawing hand on the screen without triggering unwanted touches. With a capacitive stylus, the device has to rely on inference to distinguish between intentional and incidental contact.

It's easy to see why active styluses are the most popular type, but they have some definite downsides. While you can buy a pack of four capacitive styluses on Amazon for under a tenner, you can easily pay £100 for an active pen. An active stylus also needs periodic recharging, which is a drag; while battery life typically allows for several hours of continuous use, when you do need to top up you'll usually either need to plug a cable into the stylus – which isn't exactly convenient – or snap it onto the side of your tablet to recharge wirelessly. That's a much neater solution, but it means the stylus can easily get knocked off, and potentially even lost if you're on the move.

What else makes a stylus good or bad?

Aside from the underlying technology, there are other factors that can make a big difference to your stylus experience. One is simple ergonomics: while all styluses are broadly pen-shaped, they come in different lengths, thicknesses and weights. If at all possible, it's a good idea to try one out before you buy to see how it fits your hand and writing style. A related issue is the positioning and size of any buttons or other controls – do they fall naturally under your thumb, or will it be an annoying stretch every time you want to register an action?

It's worth trying out the feel of the nib on the screen, too. With the best will in the world, dragging a plastic tip across a glass surface isn't ever going to give you the same physical

Never out of style

The computer stylus is far from a new idea: it combines two technologies that date back to the 1960s. One is a device called the RAND tablet (developed by the RAND corporation in California), which looked a lot like a modern graphics tablet: the user "draws" with the stylus onto a flat, opaque tablet on the desk in front of them, and their movements are mirrored on an upright display.

While the RAND tablet was being developed and marketed, other companies

such as IBM were experimenting with light pens, which allowed the user to navigate menus and select items by dabbing and dragging a stylus across the surface of a computer monitor – although at that time that meant a bulky upright CRT unit.

These modes of input remained in specialist use for many decades, but to get to the modern stylus interface it was necessary to combine the natural writing experience of the RAND tablet with the direct contact of a light pen. It took some time for display technology to develop to a point

where this was feasible. One of the first devices to use stylus input directly onto the screen was the Apple Newton, released in 1993.

That device is often remembered as a failure, largely because its handwriting-recognition capabilities were decidedly ropey, but the general concept of using a stylus to write directly onto the screen of a pocket-sized personal device was a hit. The format was copied by several other companies throughout the 1990s, in products such as the Palm Pilot and the Compaq iPAQ (a name which, at the time, must have seemed fresh and original). Sixty years after the first stylus system, the idea is more popular than ever.



ABOVE Light pens could be dragged across a monitor to navigate menus

LEFT The Apple Newton was one of the first devices that allowed you to write on the screen

feel as sketching with a real pencil on paper, but some implementations get closer than others. For example, we've noted that the Apple Pencil has a smooth feel that takes some getting used to, while Microsoft's latest Slim Pen uses subtle haptic feedback to simulate drag. If the stylus has replaceable nibs, there may be a selection of textures that you can choose from. Replaceable nibs also help guarantee a long working life for your stylus, even if you use it so much you wear down the rubber.

Unfortunately, because of the complexity and specific features of active stylus technology, there's usually only a limited selection of models that will work with a particular tablet. Ideally, therefore, you should consider stylus support at the point of buying a tablet, even if you don't actually add the stylus right away.

The best styluses money can buy

There are plenty of tablets, at all price ranges, that support stylus input – but you'll realise by now that they're not all alike. If you're ready to get sketching, here's our guide to the top choices.



ABOVE The Apple Pencil is a superb companion to an iPad for creatives

Adobe Illustrator and Photoshop. And while the Apple Pencil won't work with an iPhone (not even the huge iPhone 16 Pro Max), there are models available for almost every iPad

released in the past eight years.

However, you do need to make sure you buy the right one. For older tablets – including the fifth-generation mini, the third-generation Air and the first few iPad Pro devices – you'll need the first-generation Pencil (£99), which has a

1 Apple Pencil

It's no surprise that Apple tops the list – the iPad is not just the world's most popular tablet, it's particularly great for digital art, with apps such as

Procreate, Sketchbook and powerful versions of

If at all possible, it's a good idea to try a stylus out before you buy to see how it fits your hand and writing style

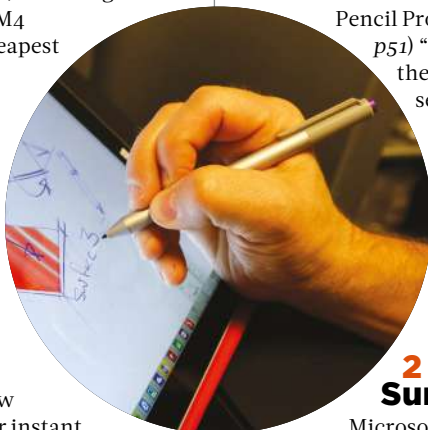
tilt sensor and 4,096 levels of pressure sensitivity. The second-generation Pencil (£129), which mostly works with iPads released between 2020 and 2022, adds snap-on magnetic charging, plus a new double-tap control for switching tools.

For newer iPads, including ones with M2 and M4 processors, the cheapest stylus option is the basic Apple Pencil USB-C (£79), which keeps the tilt detection but lacks pressure sensitivity. At the top of the range, the Apple Pencil Pro (£129) has the full set of features, plus a new squeeze control for instant menu access, rotation detection and haptic feedback that lets you know with a gentle vibration when a command has been registered. It also works with Apple's "Find My" tool, so if it falls down the back of the sofa you can track it down with an iPhone.

There's no denying that it's a confusing lineup: Apple offers a

whole matrix comparing the capabilities of the different Pencil models at tinyurl.com/363Pencil, along with compatibility details at tinyurl.com/363Pencil2. But whichever Pencil you end up with, you'll be getting a quality product.

Our reviewer deemed the Apple Pencil Pro (see issue 358, p51) "without a doubt the best stylus we've seen... I don't doubt that many artists will consider it worth trading up to a new iPad just to get their hands on the new Pencil."



2 Microsoft Surface Pen

Microsoft's answer to the Apple Pencil is a simpler proposition. The current Surface Pen (£100) is compatible with almost every Surface-branded laptop and tablet going back a full ten years: it will work with any Surface Book, Surface Go, Surface Laptop or Surface Studio, plus the Surface Pro 3 and upwards.

While Apple and Microsoft offer their styluses as optional extras, Samsung often bundles its S Pen with compatible devices

The Surface Pen isn't as loaded with features as the Apple Pencil Pro, but it has the same 4,096 levels of pressure sensitivity, and a fun "virtual eraser" on the end, meaning you can flip the stylus around and use the blunt end to rub out unwanted strokes.

For those wanting a more

LEFT Microsoft's Surface Pen is compatible with most Surface laptops and tablets

tactile tool, the Surface Slim Pen (£120) provides more of a "pen-on-paper feeling" via haptic feedback, and also includes twin barrel buttons for additional controls. It needs more upmarket hardware, however – it only works with the newest Surface Pro convertibles, plus the Surface Laptop Studio, the Surface Duo 2 and the Surface Hub 2S.

BELOW Samsung's S Pen is compatible with some of its phones as well as its tablets

To partner the Microsoft stylus, creatives may also like to consider the Surface Dial (£90) – a wireless input device shaped like a hockey puck, which you can use with your other hand to quickly select menu items and controls by spinning and pressing.



3 Samsung S Pen

While Apple and Microsoft offer their styluses as optional extras, Samsung often bundles its S Pen stylus with compatible devices – and that includes high-end phones, as well as tablets. And if you buy a mid-range phone that doesn't include a stylus, it's often possible to buy one separately.

The situation can still be a little confusing, as Samsung creates a different S Pen model for almost every device it sells, with different physical designs and feature sets. Thankfully, the features on offer are generally good. The S Pen that accompanies the Galaxy S24 Ultra smartphone (and works with some other recent S-series phones) supports 4,096 levels of pressure sensitivity, plus "Air Actions" that let you control the OS and media apps by flicking the S Pen around like a magic wand. The stylus that comes with the Galaxy Tab S10 tablet – which also works with S9 models – adds tilt sensitivity and an erase button on the barrel. ●

LEFT Many Wacom graphics tablets can be used with a stylus

BELOW The Wacom One 13 Touch drawing tablet impressed us back in issue 353

Stylus input for desktop PCs



Most styluses are designed to work with tablets. Laptops and desktop computers don't get a look in, for the same reason the original light pen never found widespread adoption – it's unnatural and tiring to try to draw or write on a vertical display.

However, there are still standalone graphics tablets that enable you to use a stylus with a conventional PC. Veteran supplier Wacom offers a selection of traditional pen tablets, similar to the original RAND tablet, at prices starting from just £56 for the

compact 188 x 142mm model (see tinyurl.com/363Wacom).

More excitingly, there's also a range of what Wacom calls pen displays – tablets with screens of their own, which connect to the host PC via USB and mirror your canvas, allowing you to effectively draw directly onto the page. We reviewed the 13in Wacom One 13 Touch (see issue 353, p68) and deemed it a "wonderful pick-up-and-use option, with a light build and a simple single-cable connection".

We were also impressed by the One 13 Touch's bright 320cd/m² screen, and the ability to use intuitive multitouch gestures to pan and zoom around the screen. The only catch is that at £580 it's not a whole lot cheaper than buying a new iPad Air and an Apple Pencil to go with it.





Save time and boost performance with 3CX V20 Update 3

In its never-ending quest to make customers' and admins' lives easier, 3CX has packed V20 Update 3 with features to save time and improve performance

3 CX has just released one of its most eagerly awaited updates, with a whole bunch of improvements that will save time and boost performance.

■ Add call processing scripts

Call processing scripts are one of 3CX V20's most powerful features. They allow you to capture calls and process them using standard C# code, giving admins with coding skills almost limitless abilities. For example, you can use a script to recognise a regular caller's ID and send them straight to the agents they've dealt with before. Or you could use factors like the time and date to process a call differently.

But this does rely on admins having C# skills. With Update 3, it's now possible for anyone to add pre-made scripts from the all-new call processing script store. No editing or coding required! Naturally, the scripts are designed to be more general, with current options such as a holiday script (for Easter or Christmas, say) and a time-based script (for example, when out of hours).

It's simple to add these scripts, too. Simply head to "Integrations" in the Admin Console, then click on "Call Scripts". Select "+ Add from Store", select the script you want and which trunk the script should be applied to (so which incoming calls the script should run on) and click "Save". Job done.

■ Easy backups

It's often forgotten that one of the great time sinks for any piece of software is invisible: backing up. With 3CX V20 Update 3, this is easier than ever because it can automatically back up all your key data to a

RIGHT It's easy to add ready-made call processing scripts

Get from Store		
Name	Description	Help
dtmf.cs	User Input IVR Script	https://www.3cx.com/docs/call-processing-script-dtmf/
holiday.cs	Play Holiday Prompts	https://www.3cx.com/docs/holiday-script/
personalparking.cs	Personal Parking with automatic return	https://www.3cx.com/docs/parking-auto-return-scripts/
agentlogin.cs	Set Agent to Log In Queue Status	https://www.3cx.com/docs/queue-agent-status-scripts/
agentlogout.cs	Set Agent to Log out Queue Status	https://www.3cx.com/docs/queue-agent-status-scripts/
resetdepartmentdefault.cs	Reset Departments Routes to Default	https://www.3cx.com/docs/force-pbx-hours-scripts/
resetdepartmentin.cs	Set Departments to force In of office route	https://www.3cx.com/docs/force-pbx-hours-scripts/
resetdepartmentout.cs	Set Departments to force Out of office route	https://www.3cx.com/docs/force-pbx-hours-scripts/
resetdepartmentbreak.cs	Set Departments to force Break route	https://www.3cx.com/docs/force-pbx-hours-scripts/
resetdepartmentholidays.cs	Set Departments to force Holiday route	https://www.3cx.com/docs/force-pbx-hours-scripts/
extavailable.cs	Set Extension Available Status	https://www.3cx.com/docs/extension-status-scripts/
extaway.cs	Set Extension Away Status	https://www.3cx.com/docs/extension-status-scripts/
extdnd.cs	Set Extension DND Status	https://www.3cx.com/docs/extension-status-scripts/
extcustom1.cs	Set Extension Custom 1 Status	https://www.3cx.com/docs/extension-status-scripts/
extcustom2.cs	Set Extension Custom 2 Status	https://www.3cx.com/docs/extension-status-scripts/
timebasecallscript.cs	Time Base Call Routing	https://www.3cx.com/docs/intercept-call-example/

Cancel

RIGHT Agents can access call transcriptions direct from the CRM

single remote location. And you can then store a copy of this one-off instance separately, in line with a thorough backup strategy.

This approach not only makes backups and restores simpler and quicker, but it also streamlines the 3CX database. As a result, your phone system will run more quickly and efficiently.

What type of data are we talking about? Think recordings, voicemails, faxes and chat images – that mix of structured and unstructured data that makes up a modern business system. And it's easy to administer thanks to all the information being displayed clearly in the admin dashboard: click on Storage and you can see the data usage and control the time when data is automatically archived. In the example shown at the bottom of this page, voicemails are archived after a day, recordings after three days.

Streamlined integrations

Once your agents have completed a call, you don't want them to waste time manually adding the transcription to your preferred CRM. Previously, the integrations with 3CX V20 only included a link; now agents can access the call transcription, along with a summary, direct from the CRM itself. This also makes it easier to search for conversations within your CRM.

And remember that whether you use Bitrix24 or ConnectWise, Salesforce or Dynamics 365, Zendesk or Zoho CRM, 3CX develops and maintains integrations to keep up with any changes (see www.3cx.com/docs/crm-integration-guides/ for details).

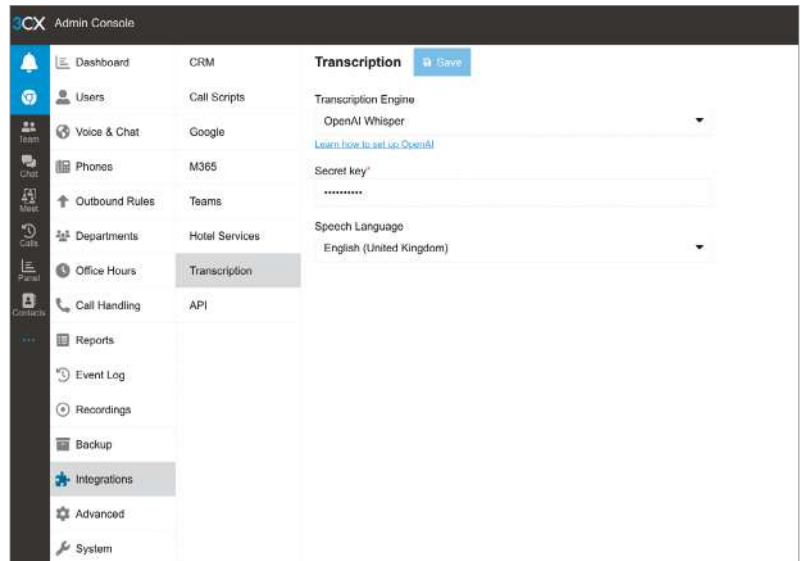
Many companies also integrate 3CX with Microsoft Teams, and again there's good news with this new update. Thanks to two-way syncing of 3CX and Teams status, users only need to set themselves to Busy in one for it to appear in the other. Previously, in Update 2, this only worked in one direction: when users updated their status in Teams it was reflected in 3CX.

And while this isn't an integration, this brings us to another neat update: users can now choose between Away or a second custom status when using the Do Not Disturb button on their phone. Just another simple time-saver to make people's lives easier.

Admin boosts

With 3CX V20 Update 3, 3CX has added a number of extra features that will simplify administrators' workloads, including a multi-edit feature. This allows admins to copy the configuration from one extension to other extensions. Configurations include call forwarding, BLF, voicemail, view and options.

Additionally, user rights are now more granular – for example, you can assign barge-in, listen or whisper to individual users independent of their role. You can now share reports to multiple emails, hide

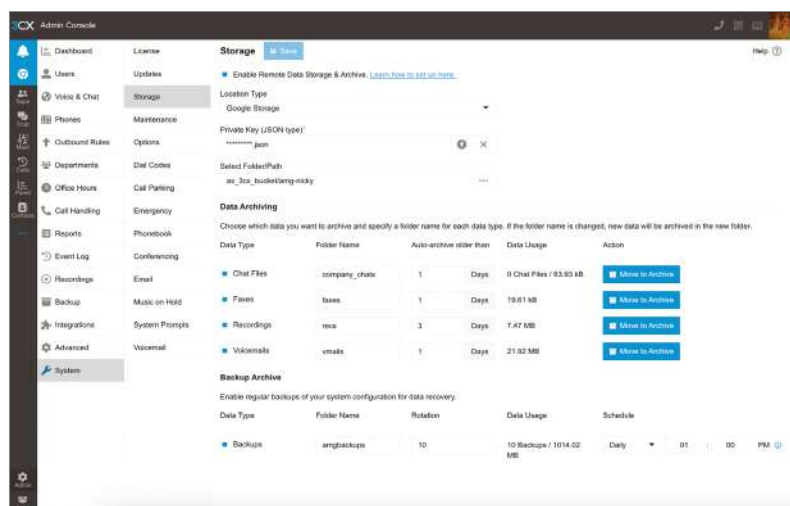
**COMMUNITY ATMOSPHERE**

If you're new to 3CX, you may not be aware that many of these features are developed in response to what users want. We won't identify people, but here's a trio of responses from 3CX partners who commented on the blog summarising the article in August.

"What an amazing update! Once this goes final I can't imagine any reason to keep instances on V18. Can't wait to test a beta of this on our in house system... The T34 and T44 phones are great additions to Yealink's product line and it's nice that they're now supported with 3CX."
A Titanium Partner

"Chock-full to the brim with great stuff, respect! There are a lot of things included here which none of us were expecting to ever see being added. Please do take that as a great compliment, because we sure are looking forward to this, as well as the other aces you might have up your sleeve for the overall future of Version 20 post Update 3 and Update 4 as well as the new v20 App."
A Titanium Partner

"Way to go 3CX!!! Christmas in October!! This is an incredible update. Bulk edit, two-way Teams sync, call transcription to CRM, and so much more. Much appreciated!"
A Platinum Partner



abandoned queue calls in "recents" for users and enable or disable 3CX Talk. And those are just a handful of the improvements.

The key here is that almost all the updates are designed to save admins time while making the system perform faster – and make life simpler for users, too.

Time to try

Despite all the improvements over the years, there are some things that don't change about 3CX. And one of those is that you can try 3CX Pro for free. No credit card required, no strings attached. And you get to choose whether you host it on your own cloud, get 3CX to host it for you or deploy on-premise on Windows or Linux. What's more, if you have fewer than ten users then you can get 3CX for free.

Remember, you're not just getting a phone system. 3CX includes video conferencing, live chat integration for your website and your choice of hardware or software phones – with feature-rich clients on Android, iPhone and Windows. Simply use the link below to get started.

LEFT You can now control when data is archived

Try 3CX FREE www.3cx.com/signup

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Intel Xeon W-2500 workstation processors

A brilliant choice for video encoding, but
it fails to land a knockout punch against
tough Threadripper competition



SCORE ★★★★★

PRICE Xeon w7-2595X, £1,681 (£2,017 inc
VAT) from scan.co.uk

If you read our recent workstations Labs (see issue 361, p78), you'll know that AMD lorded over Intel thanks to its latest Pro and non-Pro Threadripper chips. Intel has finally released a new family of workstation chips – the Xeon W-3500 and W-2500 series – that it hopes will redress the balance. It's based on Intel's 4th Generation Xeon Scalable "Sapphire Rapids" architecture, and we put a sample CPU through its paces to see if AMD has anything to worry about.

To be precise, Intel sent us the Intel Xeon w7-2595X. This is the top of the 2500-series range, with 26 cores that all support Hyper-Threading, delivering 52 threads. The base clock is 2.8GHz, with Intel's Turbo Boost Max technology pushing it up to 4.8GHz. Intel first released chips based on Sapphire Rapids at the beginning of 2023, so it's a surprise that we have our first look at it in workstation form towards the end of 2024. Admittedly, Intel released the Xeon W-2400 family at the end of 2023, but draw your own conclusions from the fact that no manufacturers decided to send us workstations based on it.

Die hard

Sapphire Rapids is manufactured using a process called Intel 7. AMD has been producing CPUs and GPUs with a 7nm process since 2018, and is now on 5nm with its production silicon, so you may be surprised to discover that Intel 7 uses Intel's 10nm Enhanced SuperFin process. However, Intel claims it's equivalent to TSMC's 7nm one – AMD relies on the Taiwanese manufacturer TSMC – hence the Intel 7 name. (Intel still runs its own fabs and reckons its 7nm process will be equivalent to TSMC's 4nm process, so will be called Intel 4.)

There are two versions of Sapphire Rapids. One uses a single die (MCC), while the other packages multiple dies together (XCC). The latter is like the approach taken by AMD with its Zen architecture for its Ryzen processors. The Intel Xeon W-2500 series uses the MCC monolithic design, so no chiplets, with a current maximum of 26 cores. The 3500-series uses chiplets, and goes up to 60 cores.

For Sapphire Rapids workstation processors, no suffix means a locked multiplier, while those ending in "X" are unlocked, so our w7-2595X has tweaking potential. The amount of bandwidth afforded to peripherals and memory is promising, too: the 2500 series offers 64 PCI-E 5 lanes and up to 2TB of quad channel 4,800MHz DDR5 RAM; the 3500 series offers 112

ABOVE Intel's new family of workstation chips may finally provide some competition for AMD

lanes and up to 4TB of eight-channel memory at the same speed.

The Intel Xeon w7-2595X is priced against the 32-core version of the Threadripper, the 7970X, or the 24-core Threadripper Pro 7965WX. The Threadripper has 48 PCI-E 5 and 24 PCI-E 4 lanes, so falls behind the Intel Xeon in peripheral bandwidth. However, Threadripper Pro 7000 series CPUs offer 128 PCI-E 5 lanes.

Both types of Threadripper support DDR5 RAM up to 5,200MHz, with the non-Pro using quad-channel and the Pro octo-channel configurations. However, the non-Pro has a maximum of 1TB while the Pro goes up to 2TB. This is unlikely to

BUYING A COMPLETE XEON SYSTEM

Scan has three offerings on its site based around the Xeon w7-2595X. There's the 3XS Evolve NLE 8K optimised for video editors, which costs £6,500 inc VAT from tinyurl.com/363evolve.

Those who specialise in graphics should consider the £11,973 3CX GWP-ME A1-X, which features an Nvidia RTX 6000 Ada card and can be found at tinyurl.com/363scangwp. Or configure exactly what you want by heading to tinyurl.com/363configure.



be significant for a workstation, but Intel has the lead in this area.

It doesn't when it comes to cache, though, which can have a significant impact on performance. The Xeon 3500 series offers up to 112.5MB of Smart Cache, while the 2500 series goes up to 48.75MB. The Threadripper has 128MB or 256MB of Level 3 cache, while the Pro comes with 64MB to 384MB. The AMD price competitors to the w7-2595X have 128MB, which could give them an advantage.

Putting theory to test

The most significant issue facing the new Intel Xeon CPUs is that their core architecture lags behind that of the company's desktop chips. The cores in the 2500 and 3500 family are "Golden Cove" generation, which means they have a similar design to those in 12th gen Intel Core CPUs, albeit with more cache per core. The consumer chips are now on the 14th generation, which use Raptor Cove cores.

We set up the new Intel CPU in a test system with the help of Scan Computers, using the ASRock W790 R2 motherboard supplied by Intel and a full set of components. These included 64GB of 4,800MHz DDR5 RAM, supplied as four 16GB DIMMs to take advantage of the quad-channel memory capabilities of the Xeon. A 48GB AMD Radeon Pro W7900 GPU provided graphics acceleration, with a 1TB Corsair MP700 NVMe SSD as the boot drive, supporting PCI-E 5 x4.

An overall score of 764 in the PC Pro Real World Benchmarks was excellent but only marginally ahead of the 12-core AMD Ryzen 9 9900X used by Scan's 3XS GWP A1-R24. The result of 221 in image editing was the obvious letdown, considerably behind any workstation in our recent group test. The video encoding score of 731 and multitasking result of 966 were much more competitive.

Image editing is single-core focused, and the Maxon Cinebench 2024 results helped to explain the situation. The multicore score of 2,625 was where we would hope a decent 26-core CPU would sit. It's not up with a 32-core processor such as the Threadripper 7970X, but it beats any 16-core CPU we've seen hands down. Its single-core score of 100 wasn't so impressive, though. This was 13% behind any system in the recent labs and further underlines that the individual cores aren't as potent as the current best.

The Blender Gooseberry render corroborated the multicore results we had seen with Maxon Cinebench. The Xeon took 244 seconds to complete the frame render, which sits about where you'd expect a 26-core processor to be: between 32-core and 16-core ones. The Geekbench ML 0.6 CPU result of

CINEBENCH 2024 (CPU, MULTICORE)

Armari M64T7 Threadripper 7980X, Radeon Pro W7800	6,294
PCSpecialist Zircon Threadripper Pro 7975WX, Radeon Pro W7900	3,493
Scan 3XS A1-TR64 Threadripper 7970X, RTX 5000 Ada	3,459
Intel Xeon w7-2595X Xeon w7-2595X, Radeon Pro W7900	2,625
PCSpecialist Quantum Core i9-14900KS, GeForce RTX 4090	2,092
Scan 3XS A1-R24 Ryzen 9 9900X, RTX A4500 Ada	1,873

HIGHER IS BETTER

PC PRO MEDIA (OVERALL)

Armari M64T7 Threadripper 7980X, Radeon Pro W7800	949
Scan 3XS A1-TR64 Threadripper 7970X, RTX 5000 Ada	867
PCSpecialist Zircon Threadripper Pro 7975WX, Radeon Pro W7900	866
PCSpecialist Quantum Core i9-14900KS, GeForce RTX 4090	841
Intel Xeon w7-2595X Xeon w7-2595X, Radeon Pro W7900	764
Scan 3XS A1-R24 Ryzen 9 9900X, RTX A4500 Ada	761

HIGHER IS BETTER

BLENDER GOOSEBERRY CPU (SECONDS)

Armari M64T7 Threadripper 7980X, Radeon Pro W7800	89
Scan 3XS A1-TR64 Threadripper 7970X, RTX 5000 Ada	155
PCSpecialist Zircon Threadripper Pro 7975WX, Radeon Pro W7900	165
Intel Xeon w7-2595X Xeon w7-2595X, Radeon Pro W7900	244
PCSpecialist Quantum Core i9-14900KS, GeForce RTX 4090	318
Scan 3XS A1-R24 Ryzen 9 9900X, RTX A4500 Ada	324

LOWER IS BETTER

5,525 was superb, however, and the Adobe Media Encoder result of 111 seconds with OpenCL enabled was also close to the quickest we've seen.

We also ran SPECviewperf 2020 v3.1, which includes viewsets that are limited by CPU frequency. The PCSpecialist Zircon Extreme system in our recent Labs had the same AMD Radeon Pro W7900 graphics as our test system but partnered with a Ryzen Threadripper Pro 7975X. The PCSpecialist system consistently produced better results than our Intel Xeon setup.

Buying decisions

It's worth pointing out that we didn't have optimal cooling for this test. The Noctua NK-U12S DX-4677 used in our Scan test build is designed for CPUs with this socket type, but it employs heat pipes and two 120mm fans. It's a very good cooler, but any current highly core-dense CPU needs the best liquid cooling possible to reach its pinnacle of performance, and a compatible cooler hadn't shipped in time for this review. So it's possible more performance is to be had from

BELOW The Xeon W-3500 and W-2500 series perform well in multithreaded tasks



"While the Xeon w7-2595X is a solid performer, it's not enough to take the workstation crown back from AMD"

this processor; that said, the w7-2595 is a 250W CPU (300W in Turbo mode), whereas equivalent Threadrippers are 350W, so in theory the Intel CPU will need less potent cooling.

Nevertheless, any performance gain from more capable liquid cooling probably won't be enough to take the Intel Xeon w7-2595X ahead of the similarly priced 32-core AMD Ryzen Threadripper 7970X. It might give the 24-core AMD Ryzen Threadripper Pro 7965X a run for its money, but we'd still recommend a workstation using an AMD alternative at this price, particularly the 7970X.

It's great to see Intel putting up some competition again. But while the Xeon w7-2595X is a solid performer for multithreaded workloads and video encoding, it's not enough to wrest the workstation crown back from AMD.

Maybe when the 5th generation Intel Xeon Scalable "Emerald Rapids" arrives for this market, it will tip the scales back in Intel's favour at last.

JAMES MORRIS

ADOBE MEDIA ENCODER (CUDA/OPENCL, SECS)

Armari M64T7 Threadripper 7980X, Radeon Pro W7800	105
Intel Xeon w7-2595X Xeon w7-2595X, Radeon Pro W7900	111
PCSpecialist Quantum Core i9-14900KS, GeForce RTX 4090	120
PCSpecialist Zircon Threadripper Pro 7975WX, Radeon Pro W7900	124
Scan 3XS A1-TR64 Threadripper 7970X, RTX 5000 Ada	127
Scan 3XS A1-R24 Ryzen 9 9900X, RTX A4500 Ada	129

LOWER IS BETTER

SPECVIEWPERF MAYA VIEWSET

PCSpecialist Zircon Threadripper Pro 7975WX, Radeon Pro W7900	1,057
PCSpecialist Quantum Core i9-14900KS, GeForce RTX 4090	893
Armari M64T7 Threadripper 7980X, Radeon Pro W7800	817
Scan 3XS A1-TR64 Threadripper 7970X, RTX 5000 Ada	814
Intel Xeon w7-2595X Xeon w7-2595X, Radeon Pro W7900	740
Scan 3XS A1-R24 Ryzen 9 9900X, RTX A4500 Ada	729

HIGHER IS BETTER

SPECVIEWPERF SOLIDWORKS VIEWSET

PCSpecialist Quantum Core i9-14900KS, GeForce RTX 4090	738
Scan 3XS A1-TR64 Threadripper 7970X, RTX 5000 Ada	609
PCSpecialist Zircon Threadripper Pro 7975WX, Radeon Pro W7900	598
Scan 3XS A1-R24 Ryzen 9 9900X, RTX A4500 Ada	491
Armari M64T7 Threadripper 7980X, Radeon Pro W7800	455
Intel Xeon w7-2595X Xeon w7-2595X, Radeon Pro W7900	434

HIGHER IS BETTER

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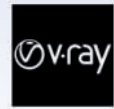
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SCORE ★★★★★

PRICE £1,499 (£1,799 inc VAT)
from pcspecialist.co.uk/reviews

When I invited PCSpecialist to submit mini PCs into our Labs (see p78), it suggested the Azena R (see p93) and the Torpedo Ultra R. In my haste, I headed to the Corsair website, saw the cute-looking picture of the 2000D RGB AirFlow chassis and that it was described as “mini” – and entirely failed to notice that the “mini” referred to miniITX. Nor did its 458mm height sink in. Yes, in comparison to most tower PCs a 200 x 271mm footprint is small, but compared to the rest of the systems in our group test it’s an absolute monster.

Having tested the Torpedo Ultra R over the course of a week, though, I still think it’s cute. And unlike most PCs, cables disappear into the shell; this is fiddly during the setup stage, as you have to lay the PC on its side to insert the video cable, Wi-Fi aerial connectors and the keyboard and mouse, but as the front panel provides easy access to two USB-A 3.2 Gen 1 ports, a USB-C 3.2 Gen 2 port and a 3.5mm combo jack, this should be a rare event.

Three addressable RGB fans sit at the front of the chassis, and that’s it for colour. Although you can peer through the metal grille sides, which reveals the RGB on the Zotac GeForce RTX 4070 graphics card, there’s no glass side to show off the Torpedo’s interior. The consequence is that this is a more difficult PC to upgrade than



in its name denotes, this CPU is maxed out with extra cache to give games a boost, and the beefy GeForce RTX 4070 graphics card is ready to take advantage.

The result was phenomenal scores across our suite of test games. At 4K and High settings, the Torpedo Ultra R returned an 150fps average in *Shadow of the Tomb Raider*, 112fps in *Dirt 5*, 83fps in *Cyberpunk 2077* and 87fps in *Assassin’s Creed*

Valhalla. RTX 4080 and 4090 systems go higher still, but the RTX 4070 offers a far more affordable route to 4K gaming. Away from games, this GPU gives you incredible acceleration whether generating AI images or in professional apps such as 3ds Max.

AMD’s 7800X3D makes less sense if you’re simply looking for multicore power. It’s fast, of course: single-core and multicore scores of 2,703 and 15,008 in Geekbench 6, and 110 and 1,039 in Cinebench 2024, emphasise that you will rarely be left waiting. Likewise a 8,961 return in PCMark 10. But choosing a Ryzen 9 will boost the core count to 12, albeit with a corresponding increase in price. Especially if you choose the 9900X or 9950X, AMD’s most recent releases.

It will also push up the power consumption, and that’s already punchy here: 86W at idle is more than most mini PCs I tested when pushed to the maximum. That consumption was

mirrored by fan noise, to the point where I would prefer not to have the Torpedo R sitting next to me on a desk.

But that’s the price you pay for this much computing power, and as always PCSpecialist provides it for a competitive price. If you tried to build this PC for yourself, not only would it cost more – I valued the total at almost £2,000 including Windows – but you wouldn’t get the excellent cable management or the security of a three-year warranty. If size, value and 3D power are your priorities, this is a great choice. **TIM DANTON**

LEFT The diminutive Torpedo Ultra R packs a powerful punch

“Having tested the Torpedo Ultra R over the course of a week, I still think it’s cute. And unlike most PCs, cables disappear into the shell”

LEFT Setup is fiddly, but once you’ve inserted the cables you’re good to go

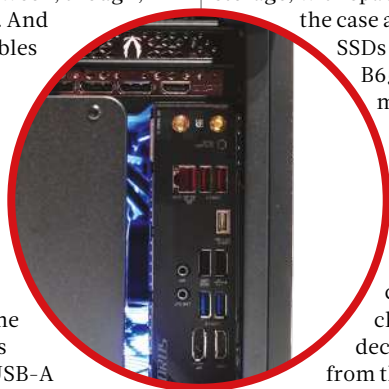
BELOW You’ll need to unclip the side and remove this side plate to access the innards

typical tower systems. Although all the steel mesh sides are easy to clip on and off, you’ll need to unscrew the support plate that holds the liquid cooler’s trio of fans to make any interior changes.

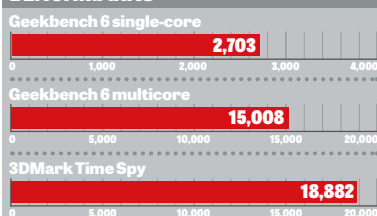
The most obvious upgrades are to storage, with space for a 2.5in SSD in the case and two more M.2 SSDs on the Gigabyte B650I Aorus Ultra motherboard. If you have dextrous fingers then it’s possible to add these drives with the board in situ, but it’s extremely cramped inside this chassis so you may decide to remove it from the case entirely while you work on it.

Personally, being lazy, I would make sure that I had all the storage I needed installed in the first place. Here, PCSpecialist provides a nippy 2TB M.2 Corsair drive, which returned 5,011MB/sec sequential reads and 4,193MB/sec writes in CrystalDiskMark, but 2TB of space can quickly disappear.

Naturally, both the DIMM sockets are occupied, with 32GB of RGB-topped Corsair Vengeance DDR5-6000 memory. These accompany an AMD Ryzen 7 7800X3D processor. As the X3D



BENCHMARKS





As QNAP marks two decades of excellence in data storage and network solutions, we are proud to have been named PC Pro Excellence Best NAS Brand 2024. From leading NAS technologies to cutting-edge AI, cloud, and IoT advancements, we've been empowering businesses and individuals around the world. Thank you for your trust and support in our journey—here's to the next 20 years of innovation!



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SCORE ★★★★★

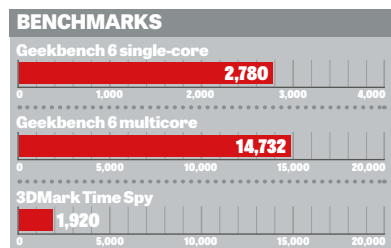
PRICE As reviewed, £1,274 (£1,529 inc VAT) from dell.co.uk

This is the second business laptop we've tested to use a Qualcomm Snapdragon X chip, following on from the excellent debut by Lenovo's ThinkPad T14s Gen 6 (see issue 360, p56). While many businesses will be nervous of rolling out Arm-based laptops, it's hard to argue with the reward of true all-day battery life.

Here, the Dell lasted 15hrs 54mins in PCMark's Modern Office test. When I used it for a working day, it still had more than 40% of charge by the time I clocked off. Until the Intel Core Ultra 200V series (see issue 362, p46) came along, you couldn't hope for that sort of life from a laptop based on an x86 processor.

It's fast, too. Geekbench is the best measure of Qualcomm's power, with the X1E-80-100 chip here powering it to 2,780 and 14,732 in the single-core and multicore tests respectively. Its NPU offers 45 TOPS, which is more than enough to handle Microsoft's Copilot+ PC features. It's also great to see Wi-Fi 7 and Bluetooth 5.4 covered by a Qualcomm chip.

Where the Snapdragon falls behind Intel and AMD rivals is its integrated graphics, returning 1,920 in 3DMark Time Spy. Still, that's better than most Qualcomm-powered systems I've tested, as the X1E-80-100 sits near the



top of the range, and returns of 34fps in *Dirt 5* and 33fps in *Shadow of the Tomb Raider* show that after-hours fun is possible at 1080p.

Perhaps not at the screen's native resolution of 2,560 x 1,600, however, as those scores fell to 24fps and 21fps. The panel itself is a good choice for the office. I particularly loved its whites, even if I found myself pushing the

brightness up to its peak 501cd/m² to overcome a visible drop-off in contrast when my viewing angle shifted. And if you're hoping for a laptop to edit photographs on then beware its 72% coverage of the DCI-P3 gamut.

The keyboard is excellent.

Keys offer cushioned resistance and plenty of travel, while the UK layout includes a double-height Enter key and large spacebar. Dell integrates a fingerprint reader into the power button, or you can use the Windows Hello-supporting IR webcam. It's a great webcam, too, with a clear image matched with excellent audio capture. Unusually for a business laptop, the speakers are good enough for listening to music.

Where Dell conforms to type is in the design. While the Latitude is slim at 16.9mm, the grey, aluminium chassis won't turn any heads. Nor is it the lightest 14in laptop around at 1.4kg. I was a little surprised to find only three USB ports, too: a pair of speedy USB-C 4 ports on the left, a single USB-A 3.2 Gen 1 port on

ABOVE The Qualcomm chip inside the laptop provides outstanding battery life

"A three-year warranty is one of the 'hidden' things that adds to the cost compared to a consumer-targeted laptop"

LEFT The three USB connectors include two versatile USB-C 4 ports

BELOW An excellent keyboard includes well spaced keys with plenty of cushioning

16GB of RAM and 512GB of storage. As always with Snapdragon X chips, you can't upgrade the memory as it's integrated into the package, but it is possible to upgrade the storage. Dell could make this easier, with seven tiny crosshead screws standing in your way, and it could also make more units

replaceable by customers rather than its own engineers – the battery falls into the latter category.

The good news is that the battery is unlikely to need replacing for a few years, by which time your three-year next-business-day warranty is likely to have expired (upgradable to five years for £109 exc VAT at time of purchase). This generous warranty is one of the "hidden" extras that adds to the cost compared to a consumer-targeted laptop, along with Windows 11 Pro rather than Home.

If you want to give Qualcomm-powered laptops a try, and already buy Dell, then this is a perfectly good choice. I would have liked it to be lighter and different from the stereotypical design, while the screen could be richer, but it's a safe way to introduce Windows on Arm to your workplace. Considering the warranty and all-round quality, it's solid value for money, too. **TIM DANTON**

SPECIFICATIONS

12-core Qualcomm Snapdragon X1E-80-100 SoC • Qualcomm Adreno graphics • 16GB LPDDR5X RAM • 14in 60Hz IPS touchscreen, 2,560 x 1,600 resolution • 512GB M.2 PCI-E Gen4 SSD • microSD card slot • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • 2x USB-C 4 • USB-A 3.2 Gen1 • 3.5mm combo jack • 54Wh battery • Windows 11 Pro • 314 x 224 x 16.9mm (WDH) • 1.4kg • 3yr on-site NBD warranty





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Samsung ViewFinity S80UD

A stylish 27in 4K screen complete with USB-C docking and an RJ45 port for a competitive price

SCORE ★★★★★

PRICE 27in, £268 (£322 inc VAT)
from uk.insight.com

Every Samsung monitor we've reviewed previously has had a consumer focus – maybe it's an Odyssey screen aimed at gamers or a Smart Monitor that doubles up as a TV. Here, though, we have two ViewFinity screens that have businesses in their sights: the S80UD on this page, the S60UD opposite.

The main difference between the two is resolution. The S80UD is a 4K panel with 3,840 x 2,160 pixels, while the S60UD makes do with 2,560 x 1,440. This is why the S80UD is more expensive, despite having a lower refresh rate of 60Hz compared to 100Hz. To confuse matters further, there are different screen sizes within the range (24in, 27in and 32in), and the 32in models use VA technology rather than IPS.

I hope you're keeping up, because I must now introduce yet another variable that might catch out unwary buyers: the S80D and S60D. The missing "U" in their name indicates the lack of a USB-C connector and an Ethernet port, which is important because one of the S60UD and S80UD's best features is their docking monitor capabilities: that USB-C port supplies up to 90W of power, enough to keep most laptops charged. The predictable duo of DisplayPort and HDMI complete the video inputs. Both monitors also include a USB-B port and a USB hub, making them a great



choice if you want to share a keyboard and mouse between connected PCs.

Any businesses wanting to show that they're buying responsibly should be reassured by the lack of coating on the plastic rear – featuring a simple but attractive grille design – which makes it easy to recycle at end of life. This "green" messaging is echoed by the default profile when you first switch on the S80UD: Eco mode. This set the screen to a brightness of 187cd/m² on my test unit, and when I pushed that up to maximum it reached 374cd/m² – exactly double. This makes a difference to energy consumption, with 23W compared to 34W, but the good news is that it still looks bright at that lower setting.

It's a high-quality panel, as you'd expect from Samsung. It covers 92% of the DCI-P3 gamut, so colours look rich, while an average Delta E of 0.41 reflects its accuracy. With a matte finish and excellent viewing angles, this would make a great addition to any office. As its 60Hz refresh rate reveals, though, this is not a great choice for gamers – and, a little surprisingly, Samsung doesn't include speakers.

Head into the OSD and you'll discover that it isn't designed for tinkerers, either. The panel's native colour temperature is around 6000K, which is a fraction warmer than the 6500K ideal for whites to look perfectly white, and when I tweaked this using the white balance tool it also reduced the contrast and the gamut coverage; not what I was looking for. You can play around with presets – Cool 1, Cool 2, Warm 1 and Warm 2 – but I quickly settled on Standard.



ABOVE The ViewFinity S80UD provides a high-quality image for a reasonable price

"The ViewFinity S80UD hits the spot for office rollouts, with a price that will delight IT budget holders"

LEFT A matte finish and good viewing angles make it ideal for office use

BELOW The superb stand offers plenty of adjustment options



There are several picture modes – Entertain, Graphic, Game, RPG, FPS, Sports – but don't expect them to change anything other than sharpening and response times. It's not like an Eizo panel, where the electronics adjust the gamut in a meaningful way, nor is there any way for IT managers to remotely manage these panels.

However, it's worth exploring the Eye Care options as these offer two blue light modes and the possibility to change the brightness depending on ambient light levels. The OSD is also responsive and easy to navigate. Some may find it fiddly to have the joystick control in the middle-bottom of the panel at the rear, but you get used to it. The stand is excellent.

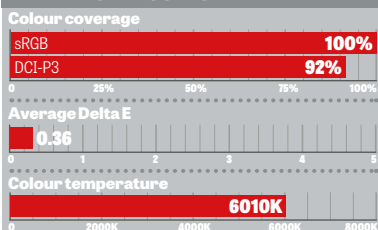
A sturdy base makes it easy to swivel the panel left or right by its 30° maximum, while 120mm of height adjustment is plenty for a 27in screen. It pivots in either direction, while the bezels on the left, right and top are slim at 8mm.

All of which means this is a tempting buy. Samsung has got the price right, too, as it undercuts the BenQ PD2706U (see issue 357, p86) by £77. Aside from the RJ45 port, the BenQ matches the S80UD feature for feature, but it offers far more colour options and even a hotkey puck to switch between them, as well as a decent pair of speakers. But the ViewFinity S80UD hits the spot for office rollouts, with a price that will delight IT budget holders and a sharp image that will equally delight end users. **TIM DANTON**

SPECIFICATIONS

27in 3,840 x 2,160 IPS panel • up to 60Hz refresh rate • 8-bit + FRC panel (1.07 billion colours) • 5ms response time • USB-C (90W power delivery) • DisplayPort 1.4 • HDMI 2 • 1GbE port • USB-B • downstream hub including 3 x USB-A 3.2 Gen 1 • 3.5mm combo jack • pivot • -30° to 30° swivel • 120mm height adjustment • -2° to 25° tilt • 613 x 220 x 434-554mm (WDH) • 6.1kg • 1yr RTB warranty

MAIN TEST RESULTS



All measurements in default profile

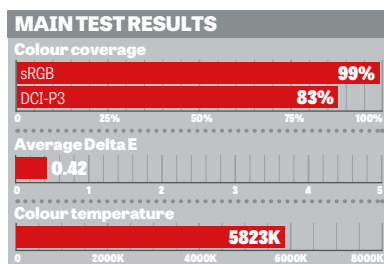
Samsung ViewFinity S60UD

A solid alternative to the ViewFinity S80UD if you're happy with a 1440p resolution rather than 4K

SCORE ★★★★★

PRICE 27in, £236 (£283 inc VAT)
from uk.insight.com

For all the reasons I mention on the opposite page, it's easy to get confused by Samsung's naming conventions. In particular, anyone looking for a modern USB docking monitor should make sure they buy



from the S60UD range rather than S60D. You even benefit from an RJ45 port here, but oddly it's positioned at the right-hand side along with the trio of USB-A ports and 3.5mm jack. That's not great from a cable management perspective.

Samsung doesn't include speakers with the S60UD, but a 100Hz refresh rate makes this a better choice for gamers than the S80UD. The question is whether you mind having 2,560 x 1,440 pixels rather than 3,840 x 2,160, which means 109 pixels per inch (ppi) compared to 163ppi. There is a slight difference in sharpness at normal viewing distances, but you'll need truly excellent eyesight to benefit. From a productivity point of view, I can't see any reason to opt for 4K on a screen this size.

One reason to choose the S80UD over the S60UD is colour coverage, with this panel covering 99% of the sRGB gamut and 83% of DCI-P3. Would most people notice the difference? I suspect not. Likewise the drop in colour temperature to around 5800K compared to 6000K, nor the fact that the S60UD's contrast ratio is superior: 1,204:1 to 1,025:1 in my tests.



ABOVE Image quality is up to par despite the lower resolution

BELOW The S60UD shares its sibling's excellent stand



In terms of features, the two are almost identical. Oddly, the S60UD has an extra DisplayPort, but they share the same slick and sturdy stand with 120mm of height adjustment and pivot support.

Likewise the OSD is identical, right down to support for picture-by-picture and picture-in-picture modes.

In some ways, the S60UD is poor value compared to the S80UD. Pay an extra £40 and you benefit from a 4K resolution and a wider colour gamut. If I was buying for myself, I'd pay that, partly because I rarely play games that benefit from a 100Hz refresh rate. But if you're buying for business use and want a USB docking monitor, I haven't seen a better alternative for under £300. **TIM DANTON**

SPECIFICATIONS

27in 2,560 x 1,440 IPS panel • up to 100Hz refresh rate • 8-bit + FRC panel (1.07 billion colours) • 5ms response time • USB-C (90W power delivery) • 2 x DisplayPort 1.4 • HDMI 2 • 1GbE port • USB-B • downstream hub including 3 x USB-A 3.2 Gen 1 • 3.5mm combo jack • pivot • -30° to 30° swivel • 120mm height adjustment • -2° to 25° tilt • 613 x 220 x 437-557mm (WDH) • 6.1kg • 1yr RTB warranty

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pro-series

mid (PRO1)



£449.99

CPU AMD RYZEN 5 8500G
Core 6 Cores - 12 Threads
Clock (3.5/5Ghz Turbo)
Mob ASUS TUF A620M-PLUS WIFI
RAM ADATA 16GB DDR5 5600Mhz
M.2 TRANSCEND 1TB M.2 nVME
GPU AMD RADEON Graphics
Case KOLINK Observatory HF MESH
O/S *NO OPERATING SYSTEM*
PSU BUILDER 500W PSU

Max (PRO2)



£979.99

CPU AMD RYZEN 5 7600X
Core 6 Cores - 12 Threads
Clock (4.7/5.3Ghz Turbo)
Mob ASUS PRIME B650M-A WIFI II
RAM ADATA 32GB DDR5 5600Mhz
M.2 TRANSCEND 1TB M.2 nVME
GPU NVIDIA RTX4060 TI 16GB
Case 1stPlayer D3-A aRGB - Black
O/S *NO OPERATING SYSTEM*
PSU CIT 700W PSU

UBER (PRO3)



£1159.99

CPU INTEL Core i5 14600K
Core 14 Cores - 20 Threads
Clock (2.6/5.3Ghz Turbo)
Mob ASUS B760M-K
RAM ADATA 32GB DDR5 5600Mhz
M.2 ADATA 2TB S70 Blade M.2 nVME
GPU NVIDIA RTX4060 TI 16GB
Case GAMEMAX F15M MESH
O/S *NO OPERATING SYSTEM*
PSU BEQUIET 850W Gold PSU

Aurora RANGE

i3



[AUR1]

£629.99

CPU INTEL Core i3 14100F
Core 4 Cores - 8 Threads
Clock (3.5/4.7GHz)
Mob ASUS B760M-K
RAM ADATA 16GB DDR5 5600Mhz
M.2 TRANSCEND 1TB M.2 nVME
GPU NVIDIA RTX3050 8GB
Case GAMEMAX Abyss Mini RGB
O/S MICROSOFT Windows 10/11
PSU CIT 600W Bronze PSU

i5



[AUR2]

£999.99

CPU INTEL i5 14400F
Core 10 Cores - 16 Threads
Clock (Turbo 4.7Ghz)
Mob ASUS B760M-K
RAM CORSAIR 32GB DDR5 6000Mhz
M.2 ADATA 2TB M.2 NVMe
GPU NVIDIA RTX4060 8GB
Case CORSAIR iCUE 4000X
O/S MICROSOFT Windows 10/11
PSU CORSAIR 650W PSU

i7

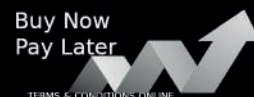


[AUR3]

£1599.99

CPU INTEL Core i7 14700KF
Core 20 Cores - 28 Threads
Clock (3.4/5.6Ghz Turbo)
Mob ASUS PRIME Z790-P WIFI - DDR5
RAM CORSAIR 32GB DDR5 6000Mhz
M.2 ADATA 1TB S70 Blade M.2 nVME
GPU NVIDIA RTX4070 12GB
Case CORSAIR iCUE 4000X RGB
O/S MICROSOFT Windows 10/11
PSU CORSAIR 650W Gold PSU

www.palicomp.co.uk



Philips 27B2U6903

This 27in 4K business monitor packs a visual punch, but Thunderbolt 4 is its main selling point

SCORE ★★★★★

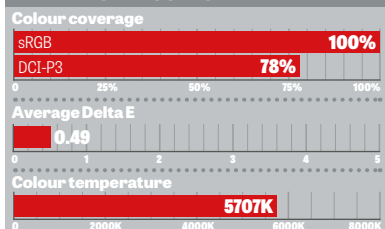
PRICE £375 (£450 inc VAT)
from uk.insight.com

How do you make your monitor stand out from the crowd? It used to be enough to add a USB-C port and an Ethernet connector, but turn to the previous spread and you'll see two 27in business monitors that include both features for around £300. Philips is upping the ante, with Thunderbolt 4, a 2.5GbE connector and a bunch of features that it claims "level up anyone's workplace".

But let's cover the basics first. This is a 27in monitor with a 4K panel based on IPS technology. Along with a 100W Thunderbolt 4 input, which is compatible with any laptop that has a USB-C port, you have a pick of inputs: two HDMI 2, one DisplayPort. This monitor also supports daisy chaining, thanks to a Thunderbolt 4 output to go along with the input (both are marked by a lightning symbol). Just note that the secondary monitor must also support Thunderbolt 4, and that's a rarity; when I tried to cheat and connect the Samsung S60UD via its USB-C port I got a "no signal" error.

There's also a nifty feature that allows you to switch between inputs by pressing Ctrl three times, so long as you're running Windows 11 and have both computers connected over USB-C. Any USB-connected keyboard and mouse will keep working, and I found it quicker and more convenient than using the shortcut button on the monitor bezel.

MAIN TEST RESULTS



All measurements in default profile



The 27B2U6903 includes two further USB-C ports (both of which can deliver 15W of power). One of these sits on the left-hand side of the monitor as you look at it, along with two USB-A ports. Two more USB-A ports are tucked away at the rear, bringing the total number of USB connections to eight.

Fortunately, Philips has remembered to include an excellent 10-bit panel alongside all this connectivity. It produces gorgeous whites, even if I had to switch to its 7500K colour balance setting to find them. Here, I measured a colour temperature of a little over 6600K, rather than the 5707K I saw out of the box (the default we print in the graphs below). Oddly, this improved its colour coverage, too, jumping from 78% of the DCI-P3 gamut in its default mode to 91%. Admittedly, I tested an early sample of the monitor, so Philips may not have worked out its perfect out-of-the-box settings, but if you buy this monitor and don't like the whites then head into the OSD.

That OSD is a mix of great and annoying. I love its simple menu layout, which is easy for a first-time user to understand, and its snappiness. I'm less fond of Philips' reliance on four front-mounted buttons; for example, I repeatedly pressed up when I meant to press down. Joysticks make OSD navigation so much easier.

The OSD is also where you access all the advanced features – the ones that level up your workplace. First up is the PowerSensor, which will detect

ABOVE The display is packed with extra features and ports

"Along with a Thunderbolt 4 input, which is compatible with any laptop that has a USB-C port, you have a pick of inputs"

LEFT Connections include Thunderbolt 4 and a 2.5GbE connector

BELOW The stylish stand allows you to slide the monitor up and down

when you're away and switch off the screen. And, if you're running Windows 11 and have set up presence management, then you can fine-tune your options (for example, choosing if it switches off whether you're 0.5m, 0.75m or 1.25m away). This is great for privacy, and it saves money too: at 200cd/m² the 27B2U6903 uses 23W, stretching to 35W at full brightness. You can also use the ambient light sensor to automatically control brightness.

Don't expect much in the way of colour control. You can manually adjust the white balance or flick between presets, such as the 7500K I mentioned earlier, but the 27B2U6903 is designed to be an office monitor rather than a screen for designers or gamers (note the 60Hz refresh rate). You can switch between Philips' SmartImage presets, with options such as Photo and Movie, but these tweak settings such as sharpness and response times rather than shifting the colour gamut. The only SmartImage preset I would regularly use is EasyRead, which

switches to mono and is great when ploughing through long documents or typing up reports.

My final words go to the excellent stand, complete with two stylish grey metal sides that leave

a hollow for the monitor to slide up and down. This monitor has won design awards from reddit and iF as a result. Nor is it for show alone, with 150mm of height adjustment to go along with 360° of swivel. Philips also includes a pair of speakers – fine for video calls, not good enough for enjoying music on – and a flip-out hook for headphones.

This all adds to the Philips 27B2U6903's undoubted utility and its appeal. The challenge is its price, because at £450 it's almost 50% more than the Samsung ViewFinity S80UD. You'll need to be certain of exploiting its bonus features, particularly daisy chaining over Thunderbolt 4, to justify paying the extra. **TIM DANTON**

SPECIFICATIONS

27in 3,840 x 2,160 IPS panel • up to 60Hz refresh rate • 10-bit panel (1.07 billion colours) • 4ms response time • Thunderbolt 4 (100W power delivery) • DisplayPort 1.4 • 2 x HDMI 2 • 2.5GbE port • downstream hub including Thunderbolt 4, 2 x USB-C 3.2 Gen 2, 4 x USB-A 3.2 Gen 2 • 3.5mm combo jack • 2 x 3W speakers • pivot • -180° to 180° swivel • 150mm height adjustment • -5° to 30° tilt • 613 x 230 x 394-544mm (WDH) • 7.2kg • 1yr RTB warranty





Meta Quest 3S

A strong set of features and low starting price make this an enticing product for those curious about VR

SCORE ★★★★★

PRICE 128GB, £242 (£290 inc VAT)
from meta.com

Meta is determined to bring VR and AR to the masses. Along with slashing the starting price of the 512GB Quest 3 (see issue 351, p56) from £620 to £470, it has introduced the Quest 3S as a sub-£300 alternative.

Despite this price, it shares many of the premium features that earned the Quest 3 a PC Pro Recommended award. Most notably, Meta sticks with the Snapdragon XR2 Gen2 processor.

This means that while this is a budget headset, you won't get budget gaming experiences. *Red Matter*, where you explore one of Saturn's moons, ran so smoothly I felt as if I was truly on this extraterrestrial world. And *Fruit Ninja*, which requires fast controller swipes to simulate sword strikes, also performed wonderfully. You can't expect PS5-like visual experiences from the XR2 chip, but if you want to play graphically demanding games you can stream games via the Xbox Game Pass app (which you can download to the headset). It helps that the spatial audio works so well, especially as there's no 3.5mm jack here.

Productivity tools are available from Meta's robust app library, including the \$25 Virtual Desktop if you wish to simulate multiple screens, but this device is far better suited to consumption than creation. I loved watching 360° travel videos on YouTube, where I almost felt like I was visiting locations in real life.

Be aware, though, that the Meta Quest 3S uses Fresnel lenses instead of the pancake lenses in the Quest 3. That means a lower field of view: 96° horizontal/90° vertical compared to 110°

horizontal/96° vertical. I also noticed minor distortion around the periphery, but since I was mostly looking at things in front of me I only spotted this when I purposely gazed at the sides.

Each lens' 1,832 x 1,920 resolution means your view isn't as sharp as the 2,064 x 2,208 on the Quest 3, but

I could still see everything clearly, even small text on web pages. The variable 90 to 120Hz refresh rate also ensures that things move smoothly across the screen.

Meta includes the same Touch Plus controllers as found with the Quest 3 and Meta Quest Pro,

which is great news. They're comfortable to hold and intuitive: when you're deep in a game, you're not thinking about how to use the controllers since they're effectively an extension of your hand. Subtle but effective haptics mean you feel resistance when using the controllers, which only adds to the immersion. They're great for navigating through menus or moving screens around, but you can perform the same functions with your hands by pinching objects using your forefinger and thumb.

It also includes colour passthrough video, so you can see what's happening



ABOVE The Quest 3S provides VR at an attractively low price

LEFT The Touch Plus controllers are intuitive and comfortable to hold

"Subtle but effective haptics mean you feel resistance when using the controllers, which only adds to the immersion"

BELOW The headset can become uncomfortable to wear for long periods

around you, which comes in handy during the setup routine as you can pair the headset with the Meta Horizon app on your phone without removing the headset. The passthrough is especially useful when you're setting up your play or workspace. You're given two options for operating in

VR: Roomscale and Stationary. Roomscale asks you to scan the room so the headset can create a virtual representation of your workspace, while Stationary gives you a circle to work within if you're sitting. You'll see a virtual mesh of polygons covering your surroundings during all of this, which only adds to the futuristic feel, and you can use the controllers to make finer adjustments such as adding furniture.

Then we come to the subject of bulk. While by no means huge, the 3S is bigger and heavier than the Quest 3, and I found it pressed on my face more. There's no IPD wheel to let you finely adjust how the headset fits, and it has the same three-point lens

adjustment as the Quest 2, which I found restrictive compared to the two black buttons inside the Quest 3 that allow for finer precision. If you wear glasses, you'll probably need to use the included

spacer to make wearing the headset more comfortable.

All of this means the Quest 3S can become uncomfortable to wear for long periods. However, due to its relatively short battery life, this might not be a problem; generally, it lasts around two hours.

Despite my criticisms, the Meta Quest 3S is a great alternative to the Quest 3 if you're curious about VR. Its performance, immersive spatial audio and strong selection of apps make it an enticing budget-friendly choice. But if you start to love VR, you'll regret not spending more on the Meta Quest 3 – especially as the 128GB version now costs £410. **TONY POLANCO**

SPECIFICATIONS

Qualcomm Snapdragon XR2 Gen 2 processor ● 8GB RAM ● 128GB/256GB storage ● dual 1,832 x 1,920 120Hz IPS screens ● 96° horizontal, 90° vertical field of view ● 2 x colour passthrough cameras ● integrated stereo speakers ● 4,324mAh battery ● USB-C power port ● Wi-Fi 6E ● Bluetooth 5.2 ● 2 x handheld controllers ● 184 x 160 x 98mm (WDH) ● 515g ● 1yr warranty



Logitech H570e

A high-quality office headset with a noise-cancelling mic and a Teams version

SCORE ★★★★★

PRICE Stereo, £42 (£50 inc VAT) from logitech.com

We live in a wireless world, but there are times when wires make sense. No faffing around with Bluetooth or worrying about battery levels; plug the device in and it will just work. That's what the Logitech H570e headset is all about: available with your choice of USB-C or USB-A connectors, and with a version certified for Teams, this is a simple headset meant for easy rollouts across an office floor. There's also a "mono" version, with only one earphone, that costs £10 less.

Still, paying either £40 or £50 remains

expensive for a wired headset. So I ordered a pair of Logitech H111 headphones for £15 from Amazon to see what extra I was getting for my money. One big difference is the use of USB rather than 3.5mm audio for the cheaper set, which means cleverer software tie-ins: with my Teams-certified H570e headset, I can use the in-line remote to accept incoming calls and fire up Teams. There are also volume up and down buttons, plus an extremely useful mute button. The H111 offers no such luxuries.

You're also buying an obvious bump up in build quality. This extends to the H570e's replaceable leatherette earpads, which are more comfortable than the foam design of the H111 (think 1980s Walkman headphones). There's also a sturdiness to the plastic, with the promise of 45% PCR as a minimum. Logitech makes no such claims for the cheaper headset, and good luck finding justifiable environmental claims for other headsets. This is one area where Logitech leads the pack, along with its use of 100%



ABOVE The in-line remote lets you accept incoming calls



"With a version certified for Teams, this is a simple headset meant for easy rollouts across an office floor"

LEFT The leatherette earpads make the H570e comfortable to wear for long periods

recyclable packaging; this extends to the H111 set, too.

In terms of output quality, there's a shade more bass audible on the H570e headset, but neither will delight listeners who want to hear every last nuance from a song.

A more obvious difference came when recording, with a far clearer result – with fewer muffled noises – from the H570e compared to the H111 in normal usage. Both headsets include background noise reduction in the mic, but I was surprised to find the H111 did a better job when I put it to the test; the H570e did reduce the noise, but the H111 got rid of it almost entirely.

Still, this was the only area where the H111 won, and overall it's obvious why the H570e headset costs three times the price. Whether you're looking to roll these out across an office or simply want a headset for taking calls on the move, it will do the job perfectly. **TIM DANTON**

SPECIFICATIONS

Wired stereo headphones • noise-cancelling mic • 30mm driver • certified for Microsoft Teams (optional) • USB-A or USB-C • 1.9m cable • 157 x 50 x 171mm (WDH) • 115g • 2yr limited warranty

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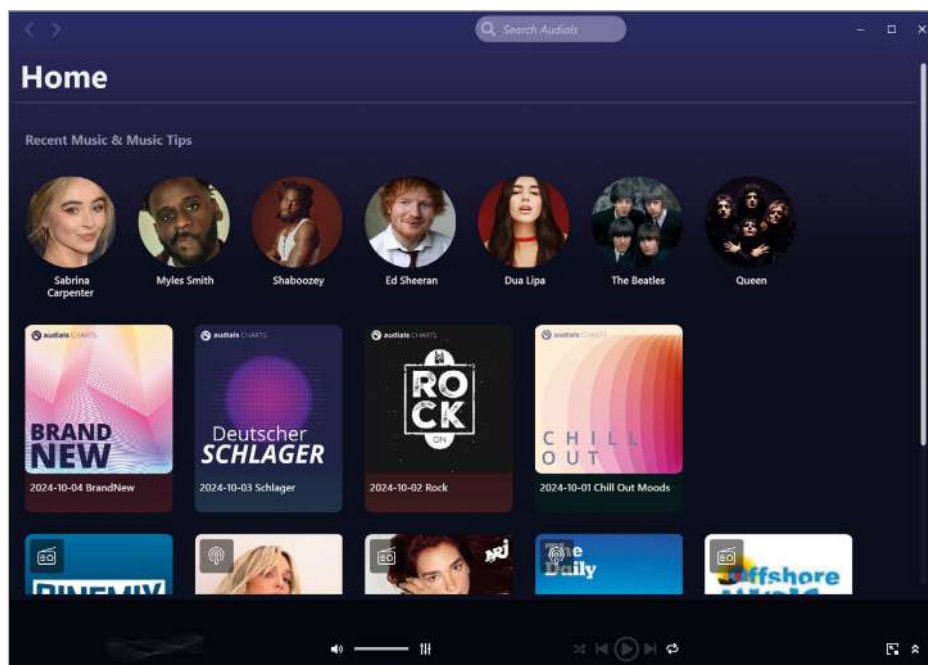
Audials One 2025 SE

With so many sites offering streaming video and music, finding what you want to watch or listen to can involve a lot of tiresome jumping from one service to another. Audials One 2025 SE is the solution: it's a one-stop-shop for all of your streaming media needs, a single application that lets you listen to music, podcasts and online radio stations, and watch TV and movies, all within one handy interface.

When you want to listen to a particular song, just search for it and Audials One will scour its catalogue of online resources to find it for you. You can download tracks in MP3 format, so they're always available for offline listening – and this is also possible with music videos, where you can either download and save the video file, or extract the audio track for later enjoyment.

There are some great features to help you grab large numbers of songs at once. For example, if you find a site that lists top music by a particular artist, you can simply copy and paste its URL into Audials One, and the app will present you with a list of all of

■ Full product worth £30
■ audials.com **REQUIRES** Windows 10 or later; 1GB hard drive space; online registration



the songs ready to listen to or download. You can also tell the program what type of music you're interested in downloading – such as a particular artist's back catalogue, for example – and it will search for and download it in the background.

Audials One can also help if streaming radio is more your thing. The interface provides a very simple way to access thousands of online radio stations from around the world, all fully searchable, and organised by genre so you'll always be able to

find something to suit your mood. From there, you can build up a list of favourites and easily jump back to particular stations when you want.

And in much the same way, you can also record online videos and music tracks, you can also record online radio stations, so you can listen to a favourite programme again in the future. Ads and presenter chat can be automatically snipped out, and any music you record will have ID3 tags added so you can easily catalogue and manage your library.



ABOVE Tune in to online radio stations from around the world. Browse genres, search and add your favourites to a list



ABOVE Audials One includes a podcast directory, so you should always be able to find something new to listen to, whatever your interests



ABOVE As well as local radio, Audials One includes a catalogue of international broadcasters that stream their output to the web

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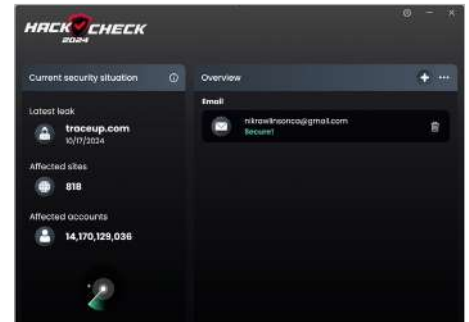
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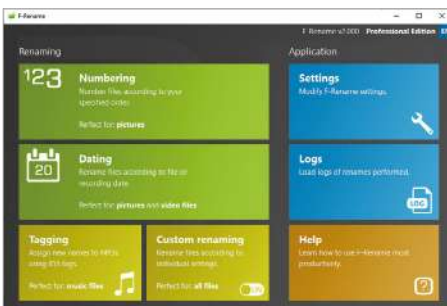
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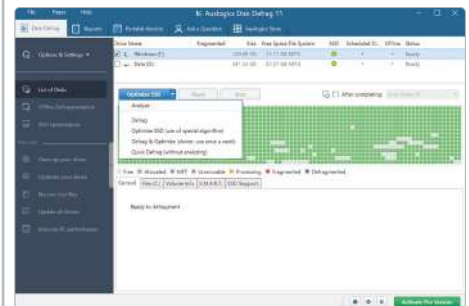
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Apple iPhone 16

A 60Hz screen and 2x optical zoom hold it back, but pound for pound it's a fine alternative to the Pro



SCORE ★★★★★

PRICE 128GB, £666 (£799 inc VAT)
from apple.com/uk

It's often hard to get excited about a new iPhone when there's a better equipped Pro version launched alongside it. But this year's model has a surprising amount in common with its upmarket sibling: it gains the action button that was previously exclusive to the iPhone 15 Pro (see issue 351, p62), and it also uses the same new camera controls as the iPhone 16 Pro (see *overleaf*). Even better, it's in line to receive the full set of Apple Intelligence features when they arrive. Could the standard iPhone be the smart buy of this generation?

■ Displayin' around

The iPhone 16 is the same size as the iPhone 15 (see issue 351, p62), with a 6.1in screen; for an extra £100 the iPhone 16 Plus has a 6.7in screen and a bigger battery but is otherwise identical.

Although the size hasn't changed, the case is now made of "aerospace-grade" aluminium, which makes it a touch lighter and purportedly more durable. Apple claims the Ceramic Shield glass is tougher than before too, though my review unit got noticeably scratched after being stuffed in my bag a few times; I strongly recommend a screen protector to keep your iPhone looking pristine.

There's also a new set of more vibrant colour options; namely pink, teal and ultramarine, alongside standard black and white. With the Action button on the left side of the phone and the new camera control on the right, in terms of physical interaction it's all but identical to the iPhone 16 Pro. In fact, I think I prefer the iPhone 16: not only do I love the new colours, I find the slightly smaller size of the standard model makes it easier to use one-handed than the Pro.

The OLED screen on this year's iPhone is as pin-sharp as ever, with enough saturation and contrast to make videos and games pop. It's not the brightest screen around, however; Apple claims it will hit a maximum of 3,000cd/m², but our lab measured a peak of 1,348cd/m². That's usable in bright sunlight, but it definitely benefits from being shaded with a hand.

I'm also frustrated to see that the refresh rate is still limited to 60Hz. This isn't a deal-breaker, but in 2024 there are plenty of (cheaper) Android phones with slick 120Hz screens, and it's disappointing that the iPhone 16's display doesn't have that same ultra-smooth feel.

■ Take your shot

The new camera control on the right-hand side of the iPhone 16 isn't just a regular clicky button. A single press instantly takes a

photo, or you can hold it down to initiate video recording. In the camera app, you can also gently slide your finger left or right on it to adjust zoom controls, exposure adjustment and more. It takes a bit of getting used to,

but it makes the iPhone feel more like a serious photographic tool; I just wish that, having come this far, Apple had added controls for shutter speed and ISO settings, too.

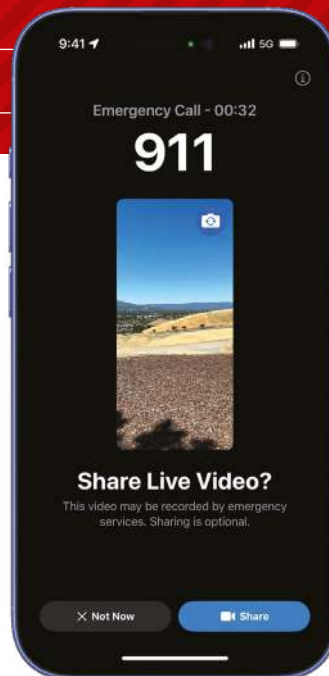
Even without those, the iPhone 16 is a fantastic camera phone. When shooting with the main 48MP camera I could hardly spot any difference in quality between pictures taken with this phone and my test shots from the iPhone 16 Pro. The phone's handling of exposure in particular was consistently impressive, even in challenging conditions: the iPhone

had no problem handling the brightness of a setting sun in the background, while still retaining depth and detail in the shadowy foreground areas – something Google's Pixel 9 struggled with. Selfies were excellent, too,

"The OLED screen is as pin-sharp as ever, with enough saturation and contrast to make videos and games really pop"

BELOW There's now an action button on the left and a camera control on the right





ABOVE The standard iPhone shares many features with its more expensive siblings

"It's a real step up from last year's model, and it even matches most of the new features of the iPhone 16 Pro"

capturing plenty of fine detail both in my face and in the background.

The 12MP ultrawide camera has been improved with an f/2.2 aperture – slightly wider than the previous generation's f/2.4 – plus, at last, the ability to capture macro photographs, a capability previously limited to iPhone Pro models. I tried this out with several close-ups of different kinds of flowers and was again hugely impressed.

While the iPhone 16 lacks a telephoto lens, it uses the same pixel-binning techniques as the iPhone 15 to achieve a remarkably clean 2x "optical" zoom. I found my results looked just as good as images taken on the Samsung Galaxy S24 Plus at the same magnification factor, and even when I dialled it all the way up to 10x zoom, the difference was small – which is pretty amazing when you consider that the Samsung has a true 3x optical zoom.

For video, like most phones at this price, the iPhone 16 can record at up to 4K resolution at 60fps. Footage once again looks great, with bags of contrast and texture. The iPhone 16 captures more detail in low light than the Galaxy S24+, although the difference isn't huge. Slow-motion video is available at 120fps at 1080p or 240fps at 720p, and the vertical camera arrangement means you can turn the phone on its side and capture 3D footage, too.

A final new feature is Audio Mix, which makes clever use of the iPhone 16's four microphones to let you adjust the audio balance or reduce

background noise after recording. It's a powerful addition, but the more I turned down the background noise on a self-narrated video, the more distorted my own voice became – so you may need to experiment to find the best balance.

■ Faster than ever

Rather than reusing the A17 Pro processor in last year's iPhone 15 Pro models, the iPhone 16 is built on Apple's new A18 chipset. Benchmark tests (see *the graphs overleaf*) confirm this is a big step up in performance: in Geekbench 6 the iPhone 16 achieved average single- and multicore scores of 3,301 and 8,033 respectively, beating all Android rivals and even outpacing the iPhone 15 Pro.

Graphics performance is improved, too, with 3DMark's Wild Life Unlimited test reporting an average frame rate of 98fps, a 36% improvement over the iPhone 15. Gaming credentials are further solidified by the addition of hardware-accelerated ray tracing – another feature previously exclusive to the 15 Pro models. Once again, it's just a shame that the 60Hz refresh rate means the gaming experience can't quite equal the perfect fluidity of rival phones.

As for battery life, Apple claims the iPhone 16 will provide up to 18 hours of online video streaming; in our tests it managed a screen-on time of 13hrs

19mins, which is around 20% longer than the iPhone 15. A charge usually got me through the day, but on heavy days I still needed to plug it in before bedtime. As the graphs overleaf show, the iPhone 16 Plus performs far better for battery life.

Still, recharging the iPhone 16 is reasonably fast: an Apple 30W charger took the phone from empty to 57% in 30 minutes, which is a respectable result. New support for 25W MagSafe charging and Qi2 mean wireless charging should be faster than before, too, though you'll need a new-style

MagSafe charger to benefit.

■ Best is yet to come

While the iPhone 16 enjoys major hardware updates, iOS 18 doesn't bring many notable new software features. There are a few, such as the ability to securely lock or hide apps, and personalisation options for the homescreen and Control Centre – but the main focus this year is clearly Apple Intelligence,

which is coming in an imminent update (see *overleaf*). Happily, when Apple Intelligence does arrive, the iPhone 16 will have access to all the same features as the Pro model – further shrinking the gap between this phone and its premium cousin.

All of this makes the iPhone 16 the best "ordinary" iPhone in years. It's a

real step up from last year's model, in terms of both features and performance, and it even matches most of the new features of the iPhone 16 Pro. Yes, it lacks the 120Hz display and the telephoto lens – but the refresh rate won't be a big problem for most people, and the iPhone's two-camera array still delivers outstanding photos and video in almost any situation, with the Audio Mix feature now on hand to improve the sound as well.

In all, for £200 less than the iPhone 16 Pro it's frankly amazing how much the iPhone 16 offers. It really feels like a premium phone at a mainstream price, and it comes in a stonking set of colour options to boot. **JOHN VELASCO**

Comparison table

	iPhone 16	iPhone 16 Plus	iPhone 16 Pro	iPhone 16 Pro Max
Starting price*	£799	£899	£999	£1,199
CPU	A18	A18	A18 Pro	A18 Pro
GPU	5-core	5-core	6-core	6-core
RAM	8GB	8GB	8GB	8GB
Storage	128GB, 256GB, 512GB	128GB, 256GB, 512GB	128GB, 256GB, 512GB, 1TB	256GB, 512GB, 1TB
LiDAR?	✗	✗	✓	✓
Screen	6.1in OLED	6.7in OLED	6.3in OLED	6.9in OLED
Resolution	2,556 x 1,179	2,796 x 1,290	2,622 x 1,206	2,868 x 1,320
Refresh rate	60Hz	60Hz	120Hz	120Hz
Wi-Fi	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7
Rear cameras	48MP/12MP	48MP/12MP	48MP/48MP/12MP	48MP/48MP/12MP
Optical zoom	2x via pixel binning	2x via pixel binning	5x	5x
Best video	4K 60fps	4K 60fps	ProRes 4K 120fps	ProRes 4K 120fps
Front camera	12MP	12MP	12MP	12MP
Battery capacity	3,561mAh	4,674mAh	3,582mAh	4,685mAh
Wireless charging?	✓	✓	✓	✓
USB-C	USB 2	USB 2	USB 3.2 Gen 2	USB 3.2 Gen 2
Dimensions (WDH)	72 x 7.8 x 148mm	78 x 7.8 x 161mm	72 x 8.3 x 150mm	78 x 8.3 x 163mm
Weight	170g	199g	199g	227g

All new iPhones support 5G, Bluetooth 5.3, Apple Pay, dual SIMS (two active eSIMs or nano-SIM and eSIM), are IP68 rated and include USB-C. *Price includes VAT from apple.com



Apple iPhone 16 Pro

A bigger display, borrowed 5x tetraprism zoom from the Max and no price hike make this the best iPhone

SCORE ★★★★★

PRICE 128GB, £833 (£999 inc VAT)
from apple.com/uk

Like the regular iPhone 16, the Pro model comes in two versions: one with a 6.3in display, and the ginormous 6.9in iPhone 16 Pro Max. If you're a believer that big is beautiful then flip the page for our full review of the Max, but I'm here to tell you that the iPhone 16 Pro is all the phone most people will need.

The first thing that's new about the iPhone 16 Pro is a larger screen. It's only 0.2in bigger than last year's model, but somehow it feels more luxurious. Perhaps it's because the bezels have also become thinner, so the case is barely any larger than the iPhone 15 Pro (see issue 351, p62), and still comfortable to use with one hand. The design should be more durable, too; Apple claims the Ceramic Shield display is 50% tougher than before, while the edging is still made of titanium rather than aluminium.

My only disappointment is that there are no flashy colour options, unlike the standard iPhone 16: Pro users can choose from white titanium, black titanium, natural titanium and the new desert titanium, which is like a soft rose gold.

Aside from its size, the OLED screen hasn't really changed from the past generation, keeping the same super-sharp 460ppi pixel density, the same maximum 120Hz refresh rate and the same maximum brightness. That's fine with me, as it still looks great; I measured a peak HDR brightness of 1,553cd/m², which is higher than the regular iPhone 16.

In fact, the most significant change is the minimum brightness, which now goes as low as 1cd/m² – half as bright as the iPhone 15 Pro. The difference is plainly visible in a dark room, and helps when you want to use your phone in a dim environment without annoying those around you.

Camera control

Like all iPhone 16 models, the Pro includes the new camera control button on the right-hand side. Strictly speaking, this isn't a button but a recessed capacitive switch that provides haptic feedback; press it

once to launch the camera, then press again to take a photo. It works well in both landscape and portrait mode, and I like the way that you can also press and hold to record a video – although if you start your capture in this way, the video stops as soon as you take your finger off the button.

Other tricks include the ability to zoom in and out by sliding your finger left and right on the button, while a soft double-press launches a mini-

menu you can scroll through to tweak things such as exposure and focus depth, or choose preset photographic styles. While there's a learning curve to the camera control, it's definitely a positive addition – and it frees up the action button on the opposite side of the phone, so you can use that for another shortcut you find useful.

Camera boost

The cameras have received upgrades, too. The main 48MP camera promises “zero shutter lag”, the ultrawide sees a resolution boost from 12MP to 48MP, and the Pro now gets the 5x optical zoom that was previously exclusive to the Pro Max series.

The main camera is stupendously responsive, and as usual the results compare positively to rival phones. My test shot of a Halloween sign came out crisp and vivid, while the Samsung Galaxy S24 Ultra (see issue 354, p58) blew out some of the highlights. However, the Pixel 9 Pro (see issue 362, p58) captured more detail in the shadows.

The upgraded ultrawide camera impressed me, too. A beach shot came out with gorgeous clarity and beautifully natural colours, while the Samsung's pic looked oversaturated and suffered from distortion at the edges. Similarly, the iPhone 16 Pro did a great job with macro close-ups of flowers, while Samsung's results were less natural and not as sharp.

The iPhone 16 Pro copes particularly well with tricky lighting. When I tried shooting a silhouetted building it somehow managed to make both the foreground and the sky look well exposed, and when I shot a string of lights outside a restaurant it kept the dynamic range controlled while still capturing masses of detail.

In all, while individual images shot on Samsung or Google's high-end

phones might have some advantages, the iPhone 16 Pro is a fantastic all-round performer. I also love the way that Photographic Styles are integrated directly into the Camera and Photos app, so you

can change skin tones and mood effects on the fly – or tweak them after the fact. Video gets a boost, too, with the arrival of 4K recording at 120fps, so you can shoot the smoothest possible video to play back on the 120Hz display, or adjust the playback speed on the fly for dramatic slow-motion videos.

Fast and formidable

With Apple's new top-of-the-line A18 Pro processor inside, the iPhone 16 Pro is a very powerful phone. The Geekbench benchmark rated it



ABOVE The 6.9in iPhone 16 Pro Max (left) towers over the 6.3in iPhone Pro



“Performance is phenomenal, battery life is better than ever, and photographers will feel positively spoilt”



LEFT You'll have to wait until December to see how Apple Intelligence shapes up

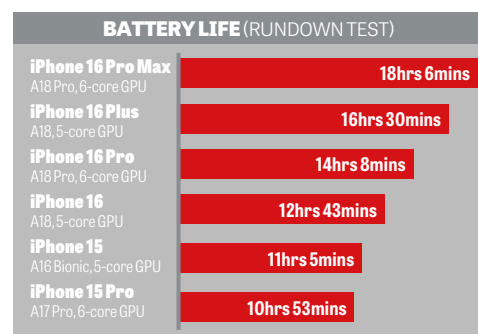
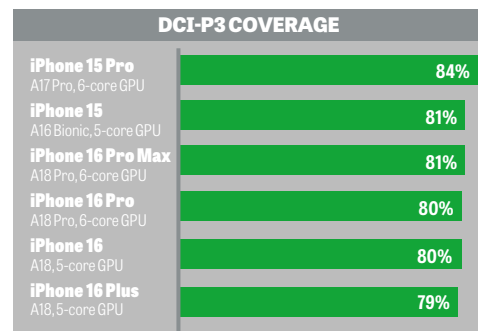
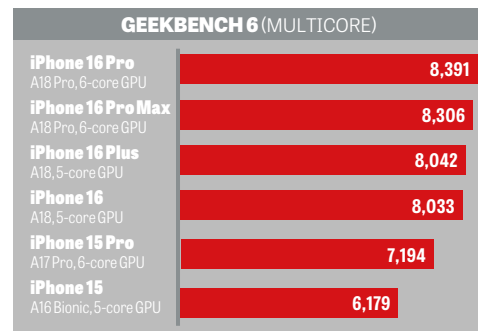
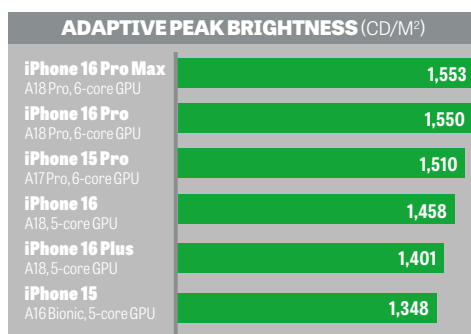
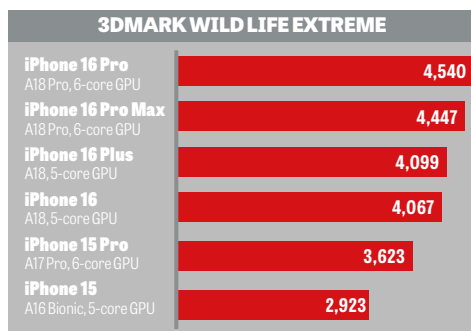
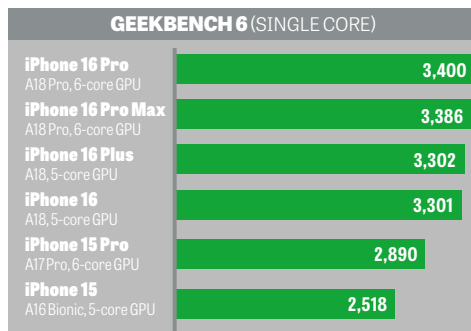
around 50% faster than the Galaxy S24 Ultra for single-core performance, and 15% higher for multicore tasks. And when I tried using Adobe Premiere Rush to transcode a 4K clip to 1080p, the iPhone 16 Pro completed the task in 21 seconds – half the time of the S24 Ultra.

Gaming performance is equally spectacular. Apple claims that the iPhone 16 Pro's six-core GPU is 20% faster than the iPhone 15 Pro and, true enough, in the 3DMark Solar Bay graphics test I found the iPhone 16 Pro scored 22% higher than the iPhone 15 Pro (although 18% behind the Galaxy S24 Ultra). Having tried a few games I'd describe the graphics as console-grade, with striking lighting and water effects.

On the software front, the latest iOS feels just as snappy as ever, and this too comes with a few new features, aimed largely at making the iPhone more customisable. For example, you can now arrange icons however you like on the home screen, and there are three screens of shortcuts in Control Centre that you can tweak how you see fit.

The updated Photos app in iOS 18, meanwhile, makes it easier to find images in your library by topic, and lets you change the look and feel of the app to your liking. Other upgrades include a dedicated Passwords app for security, several Messages improvements (such as scheduling messages and RCS support), and the ability to directly transfer money to other iPhone users with Tap to Cash. It's all good stuff, but it won't really transform your relationship with the phone – perhaps that will come with the arrival of Apple Intelligence.

As for longevity, the iPhone 16 Pro has a bigger battery than its



predecessor, and also – thanks to the new chipset – a more efficient overall design. The combined effect is salutary: in our battery test it gave us 14hrs 7mins of continuous web surfing, a huge jump from the 10hrs 53mins from the iPhone 15 Pro.

Charging speeds, however, haven't improved. After 30 minutes on a wired charger our battery only reached 56% capacity; that's not awful, but the Samsung Galaxy S24 Ultra hit 71% in the same time. The good news is that MagSafe wireless charging sees a jump from 15W to 25W, if you're using a 30W adapter.

■ A Pro with very few cons

The iPhone 16 Pro is a superlative phone. Performance is phenomenal, battery life is better than ever, and photographers will feel positively spoilt by the excellent 5x optical zoom, upgraded main and ultrawide cameras and 4K video recording at 120fps. The new camera control button is the cherry on top.

The one thing that remains to be seen is how Apple Intelligence will pan out. The Galaxy S24+ and Google Pixel 9 Pro have decent sets of AI features right now, while with the iPhone it's more of a wait-and-see situation. But even without that, the iPhone 16 Pro has enough strengths to make it a compelling alternative to any Android phone, and indeed probably the best phone you can buy for under a grand. **MARK SPOONAUER**

What is Apple Intelligence?

"Hey, Siri. Are you smart yet?" Apple Intelligence isn't coming to the iPhone 16 series until December, but I was able to try out a few of its features early.

First up, Writing Tools. This is at its strongest when summarising: it worked well when I tried it with a long entry in Apple Notes. But I also had fun asking it to rewrite an email I purposely wrote in a rude tone, choosing the professional option. The result was indeed closer to what I'd usually send.

I also used Apple Intelligence to look up how to do various things on the iPhone and received step-by-step instructions for how to screen record, for instance. So you'll definitely spend less time looking up how-tos online.

On the Photos front, my favourite feature is Memory Movie. Give the Photos app a prompt such as "Beach memories through the years with an upbeat soundtrack" and the AI goes to work sifting through all your photos and videos. And the end result was satisfying, ending with a sunset pic.

While it's overdue, I appreciate the Clean Up button, which is basically Google's Magic Eraser on iOS. Apple's version is smart enough to identify objects you might want to remove, and it works quickly. But in some cases it struggled to completely erase what I didn't want in the frame.

Siri is the biggest upgrade with Apple Intelligence. It's more conversational and forgiving of mistakes as you speak. For example, I could correct a timer from ten minutes to five minutes on the fly. Siri is also better with follow-up questions; I asked about the weather today, then said "How about the rest of the week" and I got an extended forecast.

Another plus is that you can talk to Siri by typing rather than voice alone; just tap the bottom of the iPhone 16 Pro to enter your query. Still, while Siri is definitely getting better, it doesn't have that "wow" factor that you'll experience with Gemini Live voice or GPT-4o voice, where it feels like you're having a real conversation with a chatbot.



Apple iPhone 16 Pro Max

A gigantic 6.9in screen and incredible battery life make this a superb choice for those with big, deep pockets

SCORE ★★★★★

PRICE 256GB, £999 (£1,199 inc VAT)
from apple.com/uk

If you want the maximum iPhone for your money, the 16 Pro Max is your boy. Yes, the iPhone 16 Plus is large, but the Pro Max has it beaten: with a massive 6.9in display it's the biggest iPhone Apple has ever made.

As well as an outsized screen, the Pro Max has a wedge of extra storage. The base model comes with 256GB, so while the £1,199 price is steep, it's only £100 more than the equivalent iPhone 16 Pro.

To round things off, the iPhone 16 Pro Max also claims the best battery life of any iPhone – and our testing backs that up. In our continuous web-surfing test, the iPhone 16 Pro Max lasted for an insane 18hrs 6mins, a full four hours longer than the iPhone 15 Pro Max (see issue 351, p62) and more than an hour longer than the Samsung Galaxy S24 Ultra (see issue 354, p58). It's just a shame that it doesn't recharge any more quickly than other iPhone 16 models: I found that 30 minutes of charging from a 30W charger only got the battery to 30% capacity.

Indeed, aside from its size, storage and battery life, the Pro Max is basically a blown-up carbon copy of the iPhone 16 Pro. For example, although the OLED display is bigger, its brightness, refresh rate and pixel density match those of the iPhone 16 Pro – and just like that model it can now dial down to a minimum brightness of 1cd/m², so you can use it in bed without disturbing anyone else, and get an even dimmer alarm clock.

The new camera control is present and correct, too, this being the recessed capacitive button on the right side that launches you straight into the camera. As on the other iPhone 16 models, it works well, though perhaps it isn't quite such a natural ergonomic fit for the large frame of the Pro Max. I found that getting just the right



amount of pressure took a little practice, and when I got very close to my subject for macro shots, the act of squeezing the button sometimes caused the camera to shake.

Since the cameras themselves are the same as on the iPhone 16 Pro, you get the new faster 48MP main camera, plus a 48MP ultrawide, up from the 12MP lens of last year's model. This produces brilliant close-ups, and for long-range photography the Pro Max keeps the 5x optical zoom that debuted on last year's model.

This is no longer a Max exclusive, as it's also included in the regular-sized iPhone 16 Pro, but it's still a great feature, delivering excellent results at high magnification levels. Things fall apart once you combine this with digital zoom, however: at the maximum 25x magnification, images looked fuzzy compared to the Samsung Galaxy S24 Ultra.

As on the Pro, there's support for 4K video capture at up to 120 frames per second, and you can do some pretty neat things with that footage: using the Playback Speed controls, I could slow down a table tennis match to 50%, 25% or 20%, and the footage still looked perfectly sharp and smooth.

ABOVE The biggest and best of Apple's new range is not necessarily the best value



"To round things off, the iPhone 16 Pro Max also claims the best battery life of any iPhone – and our testing backs that up"

LEFT The build quality is exactly what you'd expect from Apple

BELOW The fantastic triple camera array on the rear is identical to the iPhone 16 Pro's

For app performance, Apple's A18 Pro chip blows away the Android competition. Geekbench's tests indicate that this phone is almost 50% faster than the Galaxy S24 Ultra in single-core tasks, and around 15% faster for multicore performance. And when it comes to graphics, Apple claims its latest six-core GPU is up to 20% faster than the A17 chip in the iPhone 15 Pro Max, which the 3DMark Solar Bay graphics test confirmed.

In all, there's plenty of great stuff here, and the iPhone 16 Pro Max should get even more powerful once Apple Intelligence comes along to add a whole new range of smart features to iOS 18. The only question is whether the extra size and battery life are worth the price – and here I have to say I'm not sure the enormous screen is necessarily a plus point. It makes the phone taller, wider and heavier than the iPhone 15 Pro Max, which I thought was the near perfect size and weight for a big-screen phone, and it's more of a stretch now to do simple things such as scrolling through web pages or TikTok. I suspect most people will find the 6.3in iPhone 16 Pro more comfortably proportioned.

If you're in the market for a larger-than-life phone, however, and not put off by the max-sized price, the iPhone 16 Pro Max is the best iPhone you can buy, incorporating everything that's good about the 16 Pro, and more besides.

MARK SPOONAUER



Apple Watch Series 10

A thinner design, bigger display and sleep apnea detection make this a standout update

SCORE ★★★★★

PRICE 46mm, from £358 (£429 inc VAT)
from apple.com/uk

It's ten years since Apple unveiled its first smartwatch, and the anniversary brings an impressive update. For a start, whether you opt for the compact 42mm model or the chunkier 46mm one, the screen area is now 9% larger than on the corresponding Series 9 (see issue 351, p69). That's 30% more display space than the original Apple Watch; if you buy the 46mm version you actually get slightly more screen than the Apple Watch Ultra 2 (see issue 351, p68).

The display technology has been updated, too. The always-on display now refreshes once per second, compared to the once per minute of the Series 9. And this is Apple's first watch with a wide-angle OLED panel, which is 40% brighter for off-angle viewing compared to previous models. I found the difference clearly visible when glancing at my watch during bike rides on sunny mornings.

Despite the expanded screen, this Apple Watch is also the thinnest and lightest yet. It's around 10% slimmer and lighter than before, and I felt the difference during workouts and when wearing the watch overnight. For those who prefer something weightier, the Series 10 also introduces titanium options in natural, gold and slate finishes, with prices starting at £699.

Apple has achieved these improvements by rearranging the internals. The speaker has been compressed to the edges, and is now protected by a perforated mesh – so long, elongated slot. A new speaker and microphone system claim to improve call quality through voice isolation, and you can also now play music through the speaker. I'm not sure that's a feature many people were asking for, but I actually

did like it for background music on my rides. Happily, the band connector hasn't changed,

so any existing Apple Watch bands can still be used with the Series 10.

The latest version of watchOS brings a more customisable Photos watch face, a Vitals app that summarises your health metrics to identify trends, and the long-awaited ability to pause your activity rings. When paired with the

Apple Watch Series 10 (or the Series 9 or Ultra 2 models), the new OS additionally offers sleep apnea detection, which lets you review your breathing on a nightly basis. After you've worn the Apple Watch for at least ten nights in one month you'll start to receive alerts when possible sleep apnea is detected, along with details that you can share with your doctor. It's a great feature, though not unique: several other wearables offer similar capabilities, including the Oura Ring Gen 3 and Samsung Galaxy Watch 7.

All the useful features from previous Apple Watch models are retained. My favourites include the Double Tap gesture, the tiny QWERTY



ABOVE Despite the larger display, the Series 10 is actually slimmer than before

LEFT The speaker system is protected by a perforated mesh



BELOW The range includes titanium options in natural, gold and slate finishes



keyboard for texting, the Noise app that warns you of excessive sound exposure, period predictions, advanced running and biking metrics, the functional HomeKit app, the bedtime mode with sleep tracking and the low-power battery mode.

On that last point, my one disappointment with the Apple Watch Series 10 is that it only claims the same 18-hour battery life as every Apple Watch before it. After a decade of evolution I had hoped it would last more than a day on a charge, especially when the Apple Watch Ultra 2 gets closer to two full days of battery life. I found myself enabling low-power mode a lot, which can extend the battery life up to around 36 hours.

At any rate, the Series 10 partly makes up for it with faster charging. With a bigger and more efficient charging coil inside, the new Watch goes from empty to 80% in only 30 minutes – down from 45 minutes for previous models. In practice I found I got around eight hours of use from a 15-minute top-up, which is good for someone like me who can't seem to stick to a charging schedule.

While the Apple Watch 10 sticks to the distinctive aesthetic of previous Apple Watches, the experience of wearing one is noticeably different. It's more comfortable than past models, and the bigger, wide-angle screen makes it feel like a more refined wearable. Sure, you can make an argument for the value of the Apple Watch SE 2, or the premium features of the Apple Watch Ultra 2, but with the added benefits of faster charging and the new features in watchOS 11 – not to mention a fresh choice of colours and materials – this is the best Apple Watch for most people.

KATE KOZUCH

SPECIFICATIONS

Apple S10 with PowerVR graphics • 2in 496 x 416 OLED touchscreen • 64GB storage • 802.11n Wi-Fi • Bluetooth 5.3 • GPS • UWB 2 • NFC • eSIM • dual speakers • body temperature sensor • blood-oxygen sensor • VO2 max sensor • heart-rate sensor • altimeter • compass • gyroscope • water resistance to 50m • IP6X • battery size not stated • watchOS 11 • 39 x 9.7 x 46mm (WDH) • 42g • 1yr RTB warranty



TCL 50 Pro Nxtpaper 5G

Not the fastest, but its paper-like display and unique ability to switch off distractions make it a tempting choice

SCORE ★★★★★

PRICE £233 (£280 inc VAT)
from [margos.co.uk](https://www.margos.co.uk)

TCL's Nxtpaper phones stand out from the borg crowd thanks to their screens. If you haven't had the chance to see them, they're almost paper-like, with a matte finish and subtle, textured coating. And whether found here or on TCL tablets, they provide a welcome break from the shiny monitor, laptop or phone screens we spend most of our lives gazing at.

Yet another clever feature is that you can switch to a finish resembling E Ink screens – as found on Kindles – by switching to Ink Paper mode. This is great for reading books and even long web articles, cutting out the noise from extra colours. Or, if you want to fully commit, you can activate TCL's Max Ink mode. This will switch off background processes to save energy and prevent interruptions – Jack has posted a new cat video on Instagram! – so that you can focus on the task at hand.

But the TCL 50 Pro goes one step further by adding a Nxtpaper key on the right-hand side of the phone that shortcuts the whole process: slide it up and you can instantly move from full-colour mode to your choice of Max Ink or Ink Paper. It's a brilliant idea for any of us (all of us?) who find ourselves picking up our phones for no good reason at all during meals or when we're watching TV. Not only can you cut out interruptions, but you have a visual reminder (thanks to the mono screen) that you don't need to check your email.

All of this works brilliantly, and TCL even sells an active stylus (see our feature on p46) if you want to scrawl notes onto the surface. Thanks to the screen's finish, it will feel more like pen on paper than normal. I loved



using the screen in general, too. Reflections are a thing of the past, even under bright sunshine, and thanks to a 6.8in diagonal, peak 120Hz refresh rate and 90% coverage of the DCI-P3 gamut any content looks great: films, websites and photos.

Unless, unfortunately, I took a photo on the TCL 50 Pro at night. While in Seattle for Lenovo Tech World '24 (see p14) I went on a boat tour, where we had a chance to catch the Seattle skyline at night. The result looked okay at first glance, but zooming in revealed smudgy details. It's fine during the day, especially if you activate the 108MP sensor, but it's one obvious sign of this phone's price.

The other is its MediaTek Dimensity 6300 SoC, as reflected in the comparatively puny scores of 739 and 1,905 in Geekbench 6. This shows itself in occasional stumbles during use in Android 14, but my concern isn't so much about today as it is in three years' time. What's more, TCL commits to only two years of Android updates. You do at least get security updates until 2029.

As a 3DMark Wild Life Extreme score of 376 indicates, the TCL 50 Pro should not be the top choice for gamers. However, I fired up *Asphalt Legends Unite* and *F1 Clash*, thinking they wouldn't run well, but frame rates were more than high enough to enjoy the games. In fact, most games adapt well enough to play.

ABOVE The paper-like screen gives the TCL 50 Pro a unique touch

"Reflections are a thing of the past, even under bright sunshine, and any content looks great: films, websites and photos"

There are several other signs that this is a budget phone. One is the plain, blocky design, with little detailing to lift the dull grey finish. Others are the weak pair of speakers, its lack of an IP rating, Wi-Fi 5 rather than Wi-Fi 6 (never mind 6E) and no wireless charging support. It feels like the latter and Wi-Fi 6 should have been included at this price.

You do get 33W fast charging, which took the phone from zero to 53% in half an hour. And battery life is a strength. Anecdotally, it was rare for the phone to dip below 50% on a light usage day, and even under heavy use it survived until bedtime. You can eke out more time by switching to the Max Ink setting, where TCL reckons it can last a week without charge – even if you use it for reading for four hours a day.

There's another plus, too: 512GB of storage, with a microSD card slot if you want to add more. All of which means that I have mixed feelings about this phone. I

genuinely love the screen, and the mode-switching button is a great inclusion for all of us fighting phone addiction. What holds it back from a recommendation are its low-light camera performance and the lowly processor. If TCL boosted both of these in the next version, even if it meant pushing the price closer to £400, it would become a real A List contender.

The question is how much you're willing to pay for the screen and 512GB

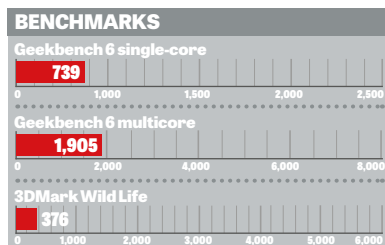
of storage. For instance, I've tried (but not yet reviewed) the Motorola G85, which is significantly faster and includes far better cameras for £299, while the G54 (see issue 355, p57) is on a par with

the TCL 50 Pro but costs £180. Both are excellent alternatives. Still, if you're spending too much time staring at your screen then the TCL 50 Pro Nxtpaper 5G is a unique way to solve the problem. **TIM DANTON**

SPECIFICATIONS

8-core 2.4GHz/2GHz MediaTek Dimensity 6300 SoC • 8GB RAM • Mali-G57 graphics • 6.8in 120Hz IPS screen with Nxtpaper technology, 1,080 x 2,460 resolution • 5G • 512GB storage • microSD card slot • triple 108MP/8MP/2MP rear cameras • 32MP front camera • Wi-Fi 5 • Bluetooth 5.3 • NFC • 5,010mAh battery • USB-C 2 • Android 14 • 76 x 8 x 168mm (WDH) • 196g • 1yr warranty

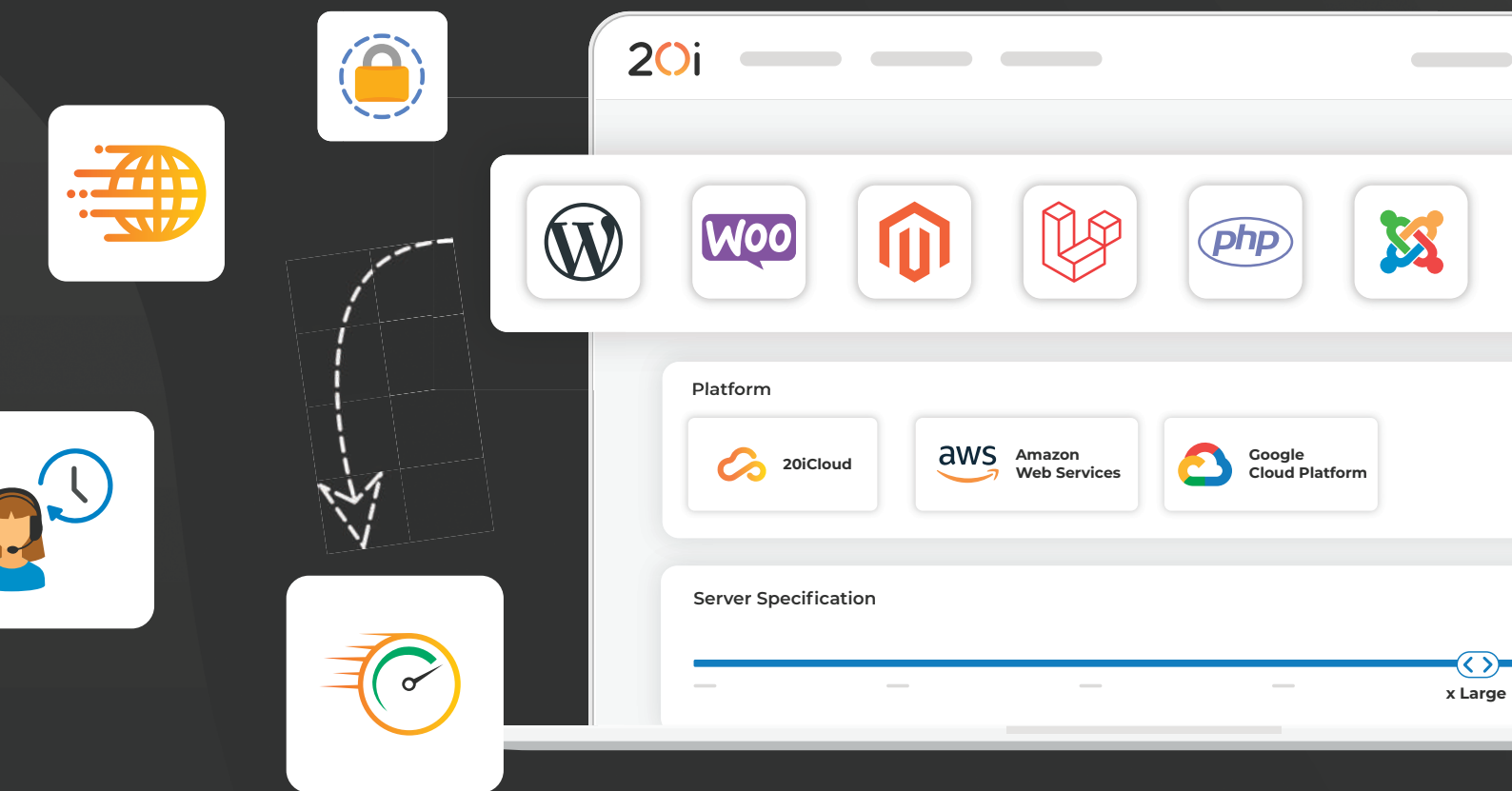
BELOW A microSD card slot lets you add to the 512GB of storage





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Samsung Galaxy S24 FE

The screen, AI features and cost savings are so good that suddenly the full-cost S24 is hard to justify

SCORE ★★★★★

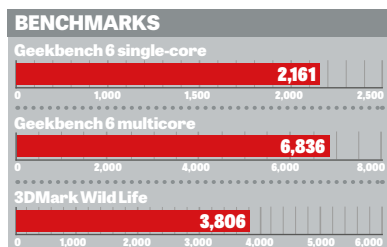
PRICE 128GB, £541 (£649 inc VAT)
from [samsung.com](https://www.samsung.com)

For years now, Samsung has been releasing its “Fan Edition” phones several months after its flagship models. The idea is to offer customers who don’t want to spend £800+ on a phone an alternative, even if it doesn’t pack all the premium features. Last year’s S23 FE was disappointing, but this year Samsung has the balance just right.

The Galaxy S24 FE receives the same level of attention as Samsung’s flagship models. That means it features the same glass-meets-metal trim that the series is known for, complete with the same IP68 water- and dust-resistance rating. On the back, the triple cameras prominently protrude with each lens outlined by a thick metal bezel. It adopts the same design language as the flagship line. And you have five colours to choose from: blue, graphite, grey, mint and yellow. Usually you don’t have as many options as this, so kudos to Samsung for offering them.

One of our criticisms of the S23 FE was its display, but there are no such concerns here. The 6.7in OLED screen packs the same rich blacks and colours as the rest of the S24 range, covering 100% of the DCI-P3 gamut in Vivid mode and peaking at 1,516cd/m². That’s actually better than the S24+ (see issue 355, p72). Add the 120Hz adaptive refresh rate and it’s a joy to use.

Arguably the biggest difference between the Galaxy S24 FE and its flagship kin is that it uses an Exynos 2400e chip rather than a Snapdragon 8 Gen 3. It isn’t as fast, but surprisingly nor is it far behind. Its Geekbench 6 scores were 2,161 and 6,836 in single- and multicore testing respectively, compared to 2,272 and 7,083 for the S24+.



Its graphics performance falls a little further behind, with an average frame rate of 24fps in 3DMark’s Wild Life Extreme test (3,806) to 30fps (4,960) from the S24+. I was pleasantly surprised that, like its siblings, the Galaxy S24 SE offers support for ray-tracing. I loaded up *Diablo Immortal* and *Age of Origins*, and even when there was intensive action happening, the games remained playable.

While it matches the S24+ with its display, the S24 FE packs a smaller 4,700mAh battery compared to 4,900mAh. But the bigger difference comes from the chipset, with Qualcomm’s clearly more power-efficient: running the same battery drain test, the Galaxy S24 FE clocked in a best time of 11hrs 25mins to 16hrs 32mins from the S24+. As a demanding user, I found myself charging the S24 FE around the middle of the afternoon because its battery would often be under 50% capacity. Luckily, a 30-minute splash with a 25W adapter takes it from zero to 53%, and the S24 FE offers 15W wireless charging as well.

Samsung sticks to the same rear camera system as the S24 and S24+.

ABOVE The superb 6.7in OLED screen is a match for its more expensive siblings



“Overall, the S24 FE pushes the S24+ so close that it begs the question of whether you’re overpaying for that phone”

LEFT The triple cameras can shoot just about anything in any light conditions

That means a 50MP main unit, a 12MP ultrawide and an 8MP telephoto camera with a 3x optical zoom. Confident shooters will also love the feature-rich camera app, which again is the same as its siblings, complete with manual modes for photos and videos, as well as support for 8K video recording.

But what really matters is the camera’s ability to shoot just about anything, in any light conditions, with good results. It holds up particularly well against the more expensive OnePlus 12 (see issue 354, p60), able to boost shadows in sunny scenes without causing issues elsewhere. The 3x zoom means you’ll never capture the detail found in the iPhone 16 Pro and Pro Max, but for this price you can’t complain.

The Galaxy S24 FE’s

low-light performance is good but not great. Its strength is brightening dark scenes, something it does better than the OnePlus 12, but it’s more susceptible to blurring unless you keep your hand very still. The 10MP selfie camera is a minor downgrade from the 12MP camera in the S24+, often producing great shots but struggling with overexposure in difficult conditions.

Overall, though, the S24 FE pushes the S24+ so close that it begs the question of whether you’re overpaying for that phone (or the S24). And I believe you are. Minor niggles aside, you’re getting the same software and experience with the S24 FE as the S24+ but for £300 less – assuming you pay for the 256GB

version, which costs £699. The S24+ comes with 256GB minimum. The only area where the S24 FE falls behind is battery life, but I’m okay with this shortcoming when it matches or almost

matches its sibling in every other area.

In fact, I’d argue that the Galaxy S24 FE is one of the best-value phones you’ll find this year. Especially when it comes with seven years of software and security updates. **JOHN VELASCO**

SPECIFICATIONS

10-core 2.9GHz/2.6GHz/1.95GHz Samsung Exynos 2400e SoC ● 8GB RAM ● Xclipse 940 graphics ● 6.7in 120Hz OLED screen, 1,080 x 2,340 resolution ● 5G ● 128/256GB storage ● IP68 ● triple 50MP/8MP/12MP rear cameras ● 10MP front camera ● Wi-Fi 6E ● Bluetooth 5.3 ● NFC ● 4,700mAh battery ● USB-C 3.2 Gen 2 ● Android 14 with One UI 6.1 ● 77 x 8 x 162mm (WDH) ● 213g ● 1yr warranty



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MINI PCS

When it comes to mini PCs, there are a handful of major players. The most famous name is Asus, which took on responsibility for developing Intel's NUC range in October 2023. Then come mini PC specialists Geekom and Minisforum, with the latter responsible for many of the brands you'll see advertised on Amazon. Beelink is another mini PC specialist – which, for whatever reason, didn't wish to send in a system to this month's test. And MSI has just entered the frame with its first NUC design, with the promise of more to come.

At first glance, there's little these manufacturers can do to lift themselves from the pack. The vast majority of mini PCs follow a similar pattern: a square-ish footprint with each side measuring 110mm to 150mm wide, a height of 30mm to 50mm and, due to the limited room inside, they're based around a mobile chip made by AMD or Intel. They all include Wi-Fi and Bluetooth along with a selection of USB ports, plus a video connector or two. How on earth are you meant to choose between them?

Hopefully the reviews on the following pages, and the buyer's guide on p82, will

help you see the differences rather than the resemblances. For instance, the amount of power they draw can have a big effect on running costs: we print their estimated running costs, over a five-year period, alongside each review. Which ports they include, and how fast they are, also becomes important. Might you want a mini PC with two RJ45 ports rather than one? Can you add more internal storage? Which exact processor is inside, and does it include an NPU?

There are also mini PCs that take a different approach. The Minisforum AtomMan X7 Ti is packed with extra features, including a webcam, OCuLink port and even a 4in touchscreen. If you can go a little larger, Minisforum again has something to tempt you with its striking Neptune HX100G. Or consider the PCSpecialist Azena R, with its laser-like focus on office duties.

So, arguably, the world of mini PCs is more interesting than traditional desktop PCs, which tend to follow even more of a formula. Let us know if you've been tempted, and what you think of your purchase, by emailing us at letters@pcpro.co.uk.

CONTRIBUTOR: Tim Danton

Don't think big, think small: the latest generation of mini PCs have all the power most people need while consuming surprisingly little electricity

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		RECOMMENDED				
	Asus NUC 14 Pro+	Geekom A8	Geekom Mini IT13	Geekom XT12 Pro	Minisforum AtomMan X7 Ti	
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	

Information

Price of reviewed system ¹	£1,006 (£1,207 inc VAT)	£749 (£899 inc VAT)	£666 (£799 inc VAT)	£583 (£699 inc VAT)	£691 (£829 inc VAT)	
Starting price of range	£649 (£779 inc VAT)	£599 (£719 inc VAT)	£458 (£549 inc VAT)	£499 (£599 inc VAT)	£691 (£829 inc VAT)	
Supplier website	icubes.co.uk	geekom.co.uk	geekom.co.uk	geekom.co.uk	store.minisforum.uk	
Part code	NUC14RVS	✗	✗	✗	UH185 Ultra	
Warranty	3yr RTB (2yr parts, first 90 days C&R)	3yr RTB (first six months C&R)	3yr RTB (first six months C&R)	3yr RTB (first six months C&R)	2yr RTB	

Processor & memory

Processor	Intel Core Ultra 9 185H	AMD Ryzen 9 8945HS	Intel Core i9-13900H	Intel Core i9-12900H	Intel Core Ultra 9 185H	
Cores	6 P-cores, 8 E-cores, 2 LE-cores	8	6 P-cores, 8 E-cores	6 P-cores, 8 E-cores	6 P-cores, 8 E-cores, 2 LE-cores	
Threads	22	16	20	20	22	
Architecture	Meteor Lake	Zen 4	Raptor Lake	Alder Lake	Meteor Lake	
NPU	✓	✗	✗	✗	✓	
Boost frequency (P-cores)	5.1GHz	5.2GHz	5.4GHz	5GHz	5.1GHz	
Boost frequency (E-cores)	3.8GHz	N/A	4.1GHz	3.8GHz	3.8GHz	

Graphics, RAM & storage

Make and model	Intel Arc	AMD Radeon 780M	Intel Iris Xe	Intel Iris Xe	Intel Arc	
Video memory	Shared	Shared	Shared	Shared	Shared	
Supplied RAM	32GB DDR5-5600	32GB DDR5-5600	32GB DDR4-3200	32GB DDR4-3200	32GB DDR5-5600	
RAM slots (free/total)	0/2	0/2	0/2	0/2	0/2	
Maximum RAM	96GB	64GB	64GB	64GB	96GB	
Supplied storage	1TB	2TB	2TB	2TB	1TB	
Storage expansion	M.2 2242 PCI-E 4	✗	M.2 2242 SATA, 2.5in SATA	M.2 2242 SATA	M.2 2230 PCI-E 4	

Front ports²

USB-C	1x USB 3.2 Gen 2x2	✗	✗	✗	1x USB 4	
USB-A	2x USB 3.2 Gen 2	2x USB 3.2 Gen 2	2x USB 3.2 Gen 2	2x USB 3.2 Gen 2	2x USB 3.2 Gen 2	
3.5mm	✗	✓	✓	✓	✓	
Other	✗	SD card reader on side	SD card reader on side	✗	Microphone, SD card reader (on top)	

Rear ports²

USB-C	2x Thunderbolt 4	1x USB 4, 1x USB 3.2 Gen 2	2x USB 4	2x USB 4	1x USB 4	
USB-A	1x USB 3.2 Gen 2, 1x USB 2	1x USB 3.2 Gen 2, 1x USB 3.2 Gen 1	1x USB 3.2 Gen 2, 1x USB 2	1x USB 3.2 Gen 2, 1x USB 2	1x USB 3.2 Gen 2, 1x USB 2	
Ethernet	1x 2.5GbE	1x 2.5GbE	1x 2.5GbE	1x 2.5GbE	2x 5GbE	
HDMI	2x HDMI 2.1	2x HDMI 2	2x HDMI 2	2x HDMI 2	1x HDMI 2.1	
3.5mm	✗	✗	✗	✗	✗	
DC input	✓	✓	✓	✓	✓	
Other	✗	✗	✗	✗	1x OCuLink, 1x DisplayPort 2	

Wireless

Wi-Fi	Wi-Fi 6E	Wi-Fi 6E	Wi-Fi 6E	Wi-Fi 6E	Wi-Fi 7	
Bluetooth	Bluetooth 5.3	Bluetooth 5.2	Bluetooth 5.2	Bluetooth 5.3	Bluetooth 5.4	

Chassis

Size (WDH)	144 x 112 x 41mm	112 x 112 x 37mm	117 x 112 x 49mm	117 x 111 x 39mm	145 x 145 x 49mm	
Kensington lock	✓	✗	✓	✓	✗	
Weight (as supplied)	623g	431g	565g	545g	860g	
Volume	0.66l	0.47l	0.64l	0.5l	1.03l	

Power

Power supply wattage	150W	120W	120W	120W	120W	
Power supply weight	303g	250g	432g	220g	277g	
Idle consumption	7W	8W	6W	6W	9W	
Peak consumption	130W	95W	55W	56W	84W	

Bundle

Operating system	Windows 11 Home	Windows 11 Home	Windows 11 Pro	Windows 11 Pro	Windows 11 Home	
Bundled software	✗	✗	✗	✗	✗	
VESA mount?	✓	✓	✓	✓	✓	
Bundled hardware	✗	Separate power button	✗	✗	1080p IR webcam, 4in 480 x 480 touchscreen, stand	

¹Prices correct at time of going to press but are subject to change. ²USB 3.2 Gen 1 = 5Gbps/sec, USB 3.2 Gen 2 = 10Gbps/sec, USB 3.2 Gen 2x2 = 20Gbps/sec, USB 4 = 40Gbps/sec.



RECOMMENDED		LABS WINNER		
Minisforum Neptune HX100G		Minisforum Venus NAB9		PCSpecialist Azena R
				
£741 (£889 inc VAT)	£324 (£389 inc VAT) 16GB/512GB	£458 (£549 inc VAT)	£458 (£549 inc VAT)	£499 (£599 inc VAT)
£741 (£889 inc VAT)	£324 (£389 inc VAT)	£458 (£549 inc VAT)	£458 (£549 inc VAT)	N/A
store.minisforum.uk	store.minisforum.uk	store.minisforum.uk	scan.co.uk	pcspecialist.co.uk/reviews
✗	✗	BOC7V61JSQ	1M-018UK	✗
2yr RTB	2yr RTB	2yr RTB	3yr	3yr RTB (1yr parts & labour; 2yr labour-only)
AMD Ryzen 7 7840HS	Intel Core i9-12900HK	AMD Ryzen 9 7940HS	Intel Core 3 100U	Intel Core i5-14400
8	6 P-cores, 8 E-cores	8	2 P-cores, 4 E-cores	6 P-cores, 4 E-cores
16	20	16	8	16
Zen 4	Alder Lake	Zen 4	Raptor Lake	Raptor Lake
✓	✗	✓	✗	✗
5.1GHz	5GHz	5.2GHz	4.7GHz	4.7GHz
N/A	3.8GHz	N/A	3.3GHz	3.5GHz
AMD Radeon RX 6600M	Intel Iris Xe	AMD Radeon 780M	Intel Graphics	Intel UHD Graphics 730
8GB GDDR6	Shared	Shared	Shared	Shared
32GB DDR5-5600	16GB DDR4-3200	32GB DDR5-5600	8GB DDR5-5200	16GB DDR4-3200
0/2	0/2	0/2	1/2	0/2
64GB	64GB	64GB	64GB	64GB
1TB	512GB	1TB	512GB	1TB
M.2 2280 PCI-E 4	2.5in SATA	M.2 2280 PCI-E 4	M.2 2230 PCI-E 4, 2.5in SATA	M.2 2230 PCI-E 4, 2 x SATA ports (internal)
1x USB 3.2 Gen 1	1x USB 3.2 Gen 1	2x USB 4	✗	1x USB 3.2 Gen 2
1x USB 3.2 Gen 1	2x USB 3.2 Gen 2	✗	2x USB 3.2 Gen 2	1x USB 3.2 Gen 1, 2x USB 2
✓ (1x mic, 1x headphone)	✓	✓	✓ (combo)	✓ (1x mic, 1x headphone, 1x headset)
Clear CMOS button	Clear CMOS button	Clear CMOS button	microSD card slot	✗
2x USB 4	1x USB 3.2 Gen 2, 1x USB 3.2 Gen 1	✗	2x Thunderbolt 4	✗
2x USB 3.2 Gen 2, 1x USB 3.2 Gen 1	2x USB 3.2 Gen 2	4x USB 3.2 Gen 2	2x USB 3.2 Gen 2	2x USB 3.2 Gen 2
1x 2.5GbE	2x 2.5GbE	1x 2.5GbE	2x 2.5GbE	1x 1GbE
2x HDMI 2.1	2x HDMI (gen not stated)	2x HDMI 2.1	2x HDMI 2.1	1x HDMI, 1x DisplayPort (gen not stated)
✗	✗	✗	✗	✓ (1x mic, 1x line out)
✓	✓	✓	✓	✓
✗	✗	✗	✗	✗
Wi-Fi 6E	Wi-Fi 6	Wi-Fi 6E	Wi-Fi 6E	Wi-Fi 6
Bluetooth 5.2	Bluetooth 5.2	Bluetooth 5.3	Bluetooth 5.3	Bluetooth 5.2
205 x 203 x 69mm	127 x 127 x 52mm	130 x 126 x 52mm	136 x 133 x 50mm	186 x 197 x 38mm
✗	✓	✗	✓	✗
145kg	615g	662g	659g	1.35kg
2.87l	0.84l	0.85l	0.83l	1.4l
262W	120W	120W	120W	120W
635g	276g	454g	410g	380g
20W	13W	6W	8W	19W
263W	83W	81W	38W	109W
Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Pro	Windows 11 Home
✗	✗	✗	✗	✗
✗	✓	✓	✓	✓
Stand	✗	✗	✗	✗

Key things to look for when buying a mini PC

Buying a mini PC isn't like buying a laptop or a fully fledged desktop PC, but a pitfall-laden experience that sits somewhere in between

■ How big is mini?

There's no formal definition of a mini PC. When we invited PCSpecialist to submit a system into this month's group test, it sent both the Azena R (see p93) and the Torpedo Ultra R (see p52). But the Torpedo proved to be ten times the size – in terms of volume – as any other system in this Labs, which is why we moved it to the main Reviews section instead. However, there is an argument that it's a mini PC, as it uses a microITX motherboard and one of Corsair's smallest chassis.

For the sake of our sanity, we decided to draw the line at three litres. That's still small enough to tuck a PC behind a monitor or sit on a stand. But there are big benefits if you decide to go smaller still, particularly under one litre. At this point, all the mini PCs on test include a VESA mount (either as a separate plate or with screws built into the chassis). That means you can attach them to a monitor – you'll probably need to buy a mounting kit – or to a monitor arm, or screw the mount into a wall and keep the PC there.

■ Processing power

As you'll see from the graphs on p94 and p95, there's a correlation between speed and size: the biggest system, the Minisforum Neptune HX100G (see p89), tops almost every chart. That's for the very obvious reason that it's a large enough to include both a desktop chip and a discrete (albeit still mobile) graphics chip in the AMD Radeon RX 6600M.



ABOVE All mini PCs support at least two 4K displays

Speed isn't everything. Every single one of these mini PCs should keep chugging happily away for five years or more

At the risk of stating the obvious, however, speed isn't everything. Every single one of these mini PCs should keep chugging happily away for five years or more, so why pay for more performance than you need? The other big advantage is running costs. Based on our measurements, for idle and peak power, we've extrapolated the five-year

running costs for each of these machines based on current domestic rates. You can see the results on p95.

So your choice very much depends on what you intend to use the mini PC for. Office or network streaming duties? Save money now and in the future with a low-performance system. Fancy playing a few games? Look for one that gets around 3,000 in 3DMark Time Spy. Need something to tackle video editing or data analysis? Then you want something that comes near the top in multicore tests such as Geekbench or Cinebench. The graphs on p94 and p95 are your friends.

Barebones options

Several of these mini PCs are available as barebones systems. There are distinct advantages of being able to choose your own RAM and storage, but here it pays to read the small print: you can easily get caught out by buying an incompatible part. The other gotcha is that barebones systems don't include a copy of Windows, so you will need to buy that separately (how fortunate that

RIGHT If you need to buy a copy of Windows, head to store.pcpro.co.uk



the official PCPro software store has such great offers; see p43). The corollary is that if you

want to run Linux then you're wasting money by buying a full system that includes Windows.

The good news is that it's incredibly easy to install memory and SSDs into these mini PCs. Almost all use four crosshead screws to secure the base in place, and then it's a simple matter of adding your chosen parts and installing your OS of choice.

■ Upgrade options

Naturally, you don't have many internal upgrade options when buying a mini PC. That shouldn't be a problem with RAM: most systems include two SODIMM sockets, and with 8GB sticks so affordable 16GB has become the de facto minimum (MSI's Cubi 1M aside, but that has a spare socket). 32GB is overkill for most people but always welcome, but it's easy to replace the supplied memory with 32GB SODIMMs in the future to



take your total to 64GB. As our feature comparison table on p80 shows, most systems support this.

You usually have more options when it comes to storage. Sometimes mini PCs will include a second M.2 slot on the motherboard (normally of the shorter M.2 2230 or 2242 format), but you'll notice that the taller units usually have space for a 2.5in SSD. This will be slower, as it uses the SATA rather than PCI Express bus, but that's fine for most devices. It also means adding storage is more affordable, as 2.5in SATA drives tend to be far cheaper per gigabyte.

Aside from the clutter effect, there's nothing wrong with adding external storage, either. Thunderbolt 4 remains the fastest and most expensive choice, and is rarely supported by PCs. However, USB-C 3.2 Gen 2 (see "Check the connections", below) delivers speedy transfers for files smaller than 10GB so remains a strong choice. And if you read our Labs mini on portable SSDs (see issue 357, p72) then you'll discover they're well priced, too.

■ Check the connections

This brings us to the external connectors. Most mini PCs include at least two monitor outputs, often HDMI, while others include DisplayPort or USB-C outputs. Every mini PC can support twin 4K displays, so we don't think that's a big issue.

It's definitely worth looking for multiple USB-C outputs, though, especially for ones with higher rated speeds. As its name

ABOVE It's easy to access the internals to add your own RAM



ABOVE All the mini PCs on test include a VESA mount so can be attached to a monitor

BELOW Some mini PCs include twin Ethernet ports

suggests, USB-C 3.2 Gen 2x2 doubles the speed of USB-C 3.2 Gen 2 (from 10Gbits/sec to 20Gbits/sec), while USB-C 4 goes up to 40Gbits/sec – even higher if you have the latest version of Windows 11 installed. You should find all the USB-A ports you need, but again with varying speeds.

A handful of mini PCs also include twin Ethernet ports. This can be particularly useful for those intending to use these PCs as media servers or for network storage, as it brings load aggregation, load balancing and redundancy into play.

Every mini PC on test (and that we've seen on sale recently) includes Wi-Fi and Bluetooth. They use the metal of the chassis to act as antenna, and we saw no drop-offs during testing. However, if you have a Wi-Fi 6E router then it makes sense to choose a mini PC that can connect over it: you'll see faster results, particularly at range. Few people need to worry about which version of Bluetooth is included, as Bluetooth 5.4 and 5.3 offer only minor improvements over Bluetooth 5.2.



How we calculate running costs

During our testing, we monitored each of these mini PCs' power consumption. Our results on p95 show their lowest and highest figures, and we used these to calculate their running costs across a five-year life. Naturally, these running costs are an estimate rather than realistic, just to give you an at-a-glance guide to aid your buying decision.

We've made a number of assumptions, top of which is that you'll keep the mini PC running for eight hours a day. We've assumed they'll be running close to idle most of the time, and pushed to the maximum for an hour. We assume you'll run the PCs every day for all five years, and that the cost of electricity will stick at the current cap of 24.5p per kWh.

■ The AI question

Four of these mini PCs include a processor that includes a neural processing unit: the Asus NUC 14 Pro+ plus three of the Minisforum PCs, namely the AtomMan X7 Ti, Neptune HX100G and Venus UM790 Pro. However, none of the chips inside supports Microsoft's Copilot+ PCs initiative, so they will rarely be of much use to you.

If you're looking for a mini PC with proper AI skills, we suggest you wait until next year – or focus on the power of the GPU, as this is what's still used by the majority of software with AI-enhanced tools.

■ Warranty and support

Unfortunately, we don't have enough data on Geekom or Minisforum to include them in the PC Pro Technology Excellence Awards (see p26). However, if you check the brands on TrustPilot then you'll see they gain around four stars – that compares to 4.7 stars for

PCSpecialist and 4.8 for Scan.

It's worth looking into the warranties, too. Geekom provides three years of cover, Minisforum two, but there's also a difference in terms of shipping costs. Geekom will cover these both ways for six months, but then expects you to pay to ship the item for repair. Minisforum covers shipping costs both ways only for the first seven days.





Asus NUC 14 Pro+

A top-quality, compact and super-fast mini PC, but you pay a steep price for these undoubted benefits

SCORE ★★★★★

PRICE £1,006 (£1,207 inc VAT)
from icubes.co.uk



While MSI has muscled in on the NUC action with its own design (see p92), Asus – which signed an agreement with Intel last year to keep developing the line – is still the first place loyalists will go when looking to update their Intel-branded NUCs.

It's also where we expect to see the latest technology, especially so with the NUC 14 Pro+, which sits at the top of the Asus range. It's not to be confused with the plain NUC 14 Pro, which comes in slim and tall variations and only supplies a maximum of 40W to the processor rather than 65W here. But don't expect Intel's all-new second generation Core Ultra inside: the 14 Pro+ was announced in January 2024, so ships with the first-gen Core Ultra 9 185H. That means its NPU fails to meet Microsoft's 40 TOPS criteria for Copilot+ PCs and that it can only give a minor boost in the small (if slowly growing) list of software that supports NPUs.

Still, this remains a fast processor and Asus squeezes every last drop out of it. The NUC 14 Pro+ topped the table in the Geekbench 6 multicore benchmark with 13,741 and carried that fine form into Cinebench, with a multicore result of 1,066. And while its overall PCMark 10 score was mid-table, it was only just behind the Minisforum Neptune HX100G – which benefits from a discrete graphics chip – in the most demanding Digital Creation section.

Even more impressively, Asus makes the most of Intel's integrated Arc graphics with a 3,960 score in 3DMark Time Spy. That's 505 more than the AtomMan X7 Ti, which has



the same processor but (we suspect) with a lower wattage. It also produced solid averages in *Shadow of the Tomb Raider*: 50fps at lowest settings, 27fps at highest (both at 1080p).

The downside to this ferocious speed is fan noise. Not all the time: when idling, you can only hear the lowest of whooshes, but this ramps up to a notable whirr as soon as the CPU is called into proper action. And when it's going full pelt, that whirr becomes a noisy whine. Luckily, you can control the fan noise in the MyAsus app, with the option of a Whisper mode that largely lives up to its name.

As usual with mini PCs, the metal frame acts as a heatsink, and one that gets notably warm to the touch. Asus applies a brushed finish that either produces a classy multicoloured-dots effect or looks cheap, depending on your view.

Rather than rely on crosshead screws, Asus provides two catches that you push to release. Slide off the white plastic base and you'll see a huge heatsink-fan dominating proceedings, but you can flip this up

ABOVE This is the only mini PC here that can be fully accessed without tools

and out of the way as it sits on a hinge. This reveals two SODIMM sockets, each filled here with a 16GB DDR5-5600 stick, and an empty M.2 2242 slot to accompany the supplied 1TB Samsung 980 Pro drive. This proved incredibly fast, with average sequential reads of 6,936MB/sec and writes of 4,944MB/sec.

There are multiple areas where the NUC 14 Pro+ leads the way for mini PCs, and that sadly includes the price

As you'd expect from a device made with Intel's backing, it includes support for Thunderbolt 4. This opens up options such as Thunderbolt Share PC-to-PC networking along with

40Gbits/sec transfer speeds and support for dual 4K monitors per port. Add two HDMI 2.1 ports and you have no shortage of output options. The rear also holds a 2.5GbE port and two USB-A ports: one USB 3.2 Gen 2 (10Gbits/sec), the other lowly USB 2. Two further USB-A 3.2 Gen 2 ports sit on the front, alongside a handy USB-C 3.2 Gen 2x2 connector, with the promise of 20Gbits/sec data transfers.

So there are multiple areas where the NUC 14 Pro+ leads the way for mini PCs, and that sadly includes the price. While the Core Ultra 5 125H version starts at £649 for a basic spec (8GB/256GB), our tested system (and you are £50 paying extra for the Samsung Pro SSD – now a 990 rather than the 980 in our test machine – compared to the standard Kingston NV3) costs £1,207 including VAT. At least that includes Windows 11 Pro and a three-year warranty.

While we love almost everything else about the NUC 14 Pro+, that price means it's only worth buying if you're after the highest levels of performance possible out of the tiniest PC you can hide discreetly away.

LEFT There's plenty of power inside the NUC 14 Pro+, even for gamers

BELOW The NUC 14 Pro+ is blessed with a wide range of ports



Geekom A8

Not the right choice if you're on a budget, but this stylish and truly mini PC packs quite a performance punch

SCORE ★★★★★

PRICE £749 (£899 inc VAT)
from geekom.co.uk



In a group test of tiny PCs, the Geekom A8 is the smallest of them all. Its footprint very nearly fits into the palm of your hand – think beer mat and you won't be far wrong – and at 37mm tall it's also the shortest system here. But what's truly incredible about this mini PC is that it's also one of the quickest on test.

That speed comes from an AMD Ryzen 9 8945HS processor, which delivers in every way. Single-core speed? With a peak of 5.2GHz it's always near the top of the charts. Multicore power? It may not have as many threads as some Intel rivals, but as all of its eight cores are geared for speed it actually beats them in most tests.

Video editing and 3D rendering? Note the A8's 10,089 in PCMark's Digital Creation test, bettered only by the Minisforum Neptune HX100G. And the A8 carried this form into our gaming tests, with terrific scores bearing in mind it uses an integrated GPU: a return of 3,215 in 3DMark Time Spy is very creditable indeed, as is an average of 30fps in *Shadow of the Tomb Raider* at 1080p and its highest settings.

You might think such power needs constant cooling, but no. When sitting idle, the A8 consumes a serene 8W and the fan is rarely called into action. It's only when you take full advantage of the CPU that the fan whirrs into life, with a maximum power draw of 95W hinting at what lies within.

At this point, you'll notice the fan noise. Although Geekom perforates the A8's aluminium shell with holes on the left- and right-hand side to aid airflow, there isn't much room inside for cooling so a thermal battle rages inside. Despite this, there's no obvious



sign of speed degradation over time: we tested this by cycling the A8 through multiple runs of the *Metro: Exodus* benchmark, and it only lost a couple of points from first to last.

Still, we felt the heat for ourselves when we removed the base

after benchmarking. You only need a crosshead screwdriver to get inside, but our initial annoyance at removing the adhesive-covered feet to expose the four screws was doubled when we discovered we had to remove a further four to remove a

baseplate (this doubles as a heatsink). Geekom uses tiny and very losable screws, too, so be careful. Be careful, too, how you handle the base, as we inadvertently disconnected the Wi-Fi card's antenna from its solder point, weakening the signal. Once in, everything you can upgrade is easy to access: two memory sockets, the M.2 2280 slot and the M.2 MediaTek MT7922 Wi-Fi 6E card.

Unlike most of its mini PC rivals, this means there's no room for any extra storage. You're relying instead on two USB-C ports, both found at the

ABOVE Perforated holes on the side of the case help with airflow

rear. One of these supports USB 4, so offers up to 40Gbits/sec data transfers – great for connecting an external GPU, an 8K monitor or a fast portable SSD. It can also deliver 15W of power, but, unlike the MSI Cubi NUC, you can't power the A8 over USB-C.

Most mini PC designs are plain to the point of being ugly, but we can imagine the minimalist A8 in a Habitat photo shoot

The DC input sits on the left of this PC's crowded rear, but Geekom still finds room for a second USB-C port (this time only supporting USB 3.2 Gen 2), two HDMI ports, two

USB-A ports and a single 2.5GbE connector. A further pair of USB-A ports sit on the front, alongside a 3.5mm jack and the power button, while Geekom finds room for a full-size SD card slot on the left.

Despite the density of ports, the A8 looks stylish. Most mini PC designs are plain to the point of being ugly, but we can imagine the minimalist A8 in a Habitat photo shoot. And it's priced to match. You can buy this in two configurations: with a Ryzen 7 8845HS and 1TB SSD for £719 or, as tested, a Ryzen 8 with a 2TB SSD for £899. Both come with 32GB of RAM.

The problem for Geekom is that Minisforum is so aggressive with the pricing of its Venus UM790 Pro. It's not as good looking as the A8, nor as slim, but £350 is a lot to pay for this – even when you consider Geekom's superior warranty, Windows 11 Pro rather than Windows 11 Home, and a slightly faster processor. The 8845HS is newer and boosts a fraction higher, but as our benchmarks on p94 show there's little to choose between the two.

Ultimately, it's value that loses the Geekom A8 a star in our ratings, but it earns a Recommended award for its unbeatable mix of size, performance and build quality.

LEFT The tiny Geekom A8 fits in the palm of your hand yet packs quite a punch

BELOW Connections include two USB-C, two HDMI and a 2.5GbE port





Geekom Mini IT13

The Mini IT13 remains a fine mini PC, especially for Intel fans, but the Core i9 version in particular is too expensive

SCORE ★★★★★

PRICE £666 (£799 inc VAT)
from geekom.co.uk



If the number of reviews on its website is any guide, the Mini IT13 is Geekom's biggest-selling mini PC in the UK. And almost all of those 100+ reviews give it five stars. So why is it gaining a mere four stars from nasty old *PC Pro*? We shall try to explain.

Perhaps the biggest reason is that time has moved on. Geekom released the IT13 a year ago, and while the Core i9-13900H remains a fine processor, it falls behind the Ryzen 9 inside both the Geekom A8 and Minisforum Venus UM790 Pro. Examine the graphs on p94 and you'll see that there isn't a single speed test where the Mini IT13 beats its rivals, unless you count its Lexar NM7A1 2TB SSD: this remains an excellent choice.

Another issue for the Mini IT13 is that its fans run loud compared to the A8 or UM790 Pro. Even when idling (and this after we had headed into the BIOS to select the low fan noise option) there was an audible whirr. Not irritating thanks to its low tone, but ever present when its rivals were often entirely silent.

So that's why the IT13 loses a star. Now to explain why it still deserves four. The first is the design, with a striking aquamarine finish that stands out from the crowd. As we've come to expect from Geekom, build quality is excellent: it feels like you can drop it with impunity. Geekom even claims that it can "run stably 24/7 in environments ranging from -20°C to 55°C", but we'll have to take its word on that.

This is also one of the simplest mini PCs to upgrade. There are no irritating adhesive feet to remove, with the four crosshead screws that keep the base secure in plain sight.



They're also captured, so won't come loose, with the only possible mishap coming if you dislodge the SATA cable that's attached to the motherboard – but that brings us to an obvious benefit, which is that you can slide in a 2.5in SATA drive with the minimum of fuss, as everything sits ready and waiting (including the caddy).

You can add a second M.2 2242 drive too, but note that this socket supports SATA (up to 1TB), not PCI-E 4 drives. The two SODIMM sockets were filled with a pair of 16GB DDR4-3200 DIMMs in our review model, but you can easily swap them out for up to 64GB. You can also replace the M.2 Intel Wi-Fi AX211 card, but as this provides Wi-Fi 6E and Bluetooth 5.3 we don't see any immediate need.

The remaining expandability stems from external connectors. A full-size SD card slot sits on the left-hand side, with two USB-A ports and a 3.5mm jack at the front. But things get more interesting at the

ABOVE The IT13 is a fine mini PC, but it's not at the cutting edge

rear, with Geekom including two USB-C ports. These can be used to attach external storage or displays up to 8K, with two HDMI 2.0 ports meaning that a four-display setup is within reach. A single 2.5GbE port and two USB-A ports (one 3.2 Gen 2, the other USB 2) round out the

This is one of the simplest mini PCs to upgrade. There are no irritating adhesive feet to remove, with four screws in plain sight

connections, other than the DC jack – which you will need, as neither of the USB-C ports can be used to power the Mini IT13.

Geekom currently sells this system in three configurations: Core i5-13500H with 16GB of RAM and a 512GB SSD for £549, an i7-13620H with 32GB of RAM and 1TB of storage for £599, or our tested configuration with a 2TB SSD, 32GB RAM and the Core i9-13900H for £799. Of the three, the Core i7 hits the sweet spot for value: it has four E-cores to the i9's eight, and its six P-cores don't peak so high (4.9GHz rather than 5.3GHz), but it remains a fine mobile processor.

Those who like to game should stick with the i9, however, as its Iris Xe graphics (as opposed to Intel UHD Graphics for the i7) produced respectable results in our tests. The Mini IT13 achieved 35fps in *Shadow of the Tomb Raider* at 1080p and lowest settings, while 1,917 in 3DMark Time Spy is respectable. As are all its results: scores of 2,438 and 11,698 in Geekbench 6 would have been considered great 18 months ago.

But, as we said at the start, times have changed. This mini PC only came close to topping our charts once, and that was for estimated running costs due to its low power demands. Unless its price drops dramatically, we would opt for the Minisforum Venus UM790 Pro instead.

LEFT The striking aquamarine finish certainly stands out from the crowd

BELOW Two USB-C and two HDMI 2.0 ports mean you can attach up to four displays



Geekom XT12 Pro

Sometimes it makes sense to buy last-gen technology, but in this case we'd steer clear despite its quality

SCORE ★★★★★

PRICE £583 (£699 inc VAT)
from geekom.co.uk



Geekom has so many mini PCs in its range that it's hard to identify one from the other by name alone, but "XT12 Pro" provides clues. First, the 12 indicates that it includes 12th generation Intel chips – Geekom sells the XT13 Pro with a 13th gen Core i7-13620H (£649) or i9-13900H (£949) – while the Pro tells you that it ships with Windows 11 Pro rather than Home.

Physically, the two are identical, and whichever model you opt for you'll enjoy top-quality build quality. A pleasing honeycomb finish stretches to the sides and across the bottom, which also keeps its weight down and aids airflow. In general use it's extremely quiet – almost silent – but you will notice the fans kicking into action when it's pushed. We weren't at all surprised that it has low energy demands, hovering around 6W in idle and reaching 56W at its peak. That leads to our low estimated five-year running cost of £44.

In return, you aren't buying the fastest system in the world. Our XT12 Pro review model, with a Core i9-12900H inside, scored modestly in every test compared to its rivals this month. Gamers in particular won't be impressed by a 32fps average in *Shadow of the Tomb Raider* at 1080p and its lowest settings. You'll probably need to drop to 720p for smooth gameplay in your title of choice.

This doesn't mean the XT12 Pro is slow in general use. We were quite happy using this mini PC for office tasks, and web pages all responded snappily. As did Windows, with none of the sluggishness you sometimes

find on lesser systems. That's reflected in a return of over 2,300 in Geekbench's single-core test, and its multicore result of 10,097 reflects the presence of six P-cores and eight E-cores (giving 20 threads in total).

Geekom helps by providing a speedy 1TB SSD, which sat near the top of our benchmarks, and in a surprise move for such a compact chassis there's room for a second M.2 SSD inside. However, it won't be as quick as the main unit: the empty M.2 2242 slot only supports SATA drives. Typically, a 512GB drive costs around £50 to £60, a 1TB drive around the £85 mark.

Connectivity is mixed. There are twin HDMI ports, and thanks to a pair of USB-C ports you can actually hook up four 4K screens. Both those USB ports support the fastest USB 4 standard (40Gbits/sec), so are a great choice for adding external drives, a

ABOVE The honeycomb finish looks great, keeps the weight down and helps airflow

We can't ignore the fact that the Minisforum Venus NAB9 offers the Core i9-12900HK for very nearly half the price

LEFT The compact chassis has room for a second M.2 SSD

BELOW The solid selection of ports includes two HDMI connectors

docking station or even an external GPU. Two USB-A ports complete the rear connectivity options, one of which is a USB 3.2 Gen 2 connector (10Gbits/sec), with a further two fast USB-A ports at the front. It would have been convenient to have a

USB-C port on the front as well, but overall it's a solid selection. Add Wi-Fi 6E along with Bluetooth 5.2 and there's little to moan about.

Our only real moan, in fact, concerns value for money. The Core i7-12650H version of the XT12 Pro scores better here, costing £599 but still shipping with 32GB of RAM and a 1TB SSD, but we can't ignore the fact that the Minisforum Venus NAB9 offers the Core i9-12900HK – albeit with 16GB of RAM and a 512GB SSD – for very nearly half the price.

That difference is reflected in a number of ways – a three-year warranty rather than two years, Windows 11 Pro instead of Home, better connectivity – but Geekom needs to cut the price still further to be a compelling alternative to the Minisforum Venus UM790 Pro. This is just as well made as the XT12 Pro, and just as well connected, but it's also far faster and costs under £500.

Geekom tries to sweeten the deal with voucher codes (5% as we write this) and free gifts, but that's not enough. If you love the design, we'd instead suggest you consider the XT13 Pro. The Core i7-13620H model costs £50 less than the i9-12900H system we tested, and we would expect it to be near-identical in most benchmarks – and faster at gaming.





Minisforum AtomMan X7 Ti

Expensive, and it can be noisy, but in return you're buying a mini PC that's quite different to anything else

SCORE ★★★★★

PRICE £691 (£829 inc VAT)
from store.minisforum.uk



While Minisforum makes dozens of conventional mini PCs, it also likes to experiment with new designs. These often appear under its high-end AtomMan brand, and the most striking feature of the X7 Ti is its 4in touchscreen. Download the software – a clumsy process – and it gives you an at-a-glance summary of CPU, GPU, RAM and SSD usage and temperatures. Touch the time and a large analog clock appears, or you can use it to switch between energy-saving, balanced and performance modes.

I kept it in the latter during testing, as the Core Ultra 9 185H inside deserves to be unleashed. With 32GB of DDR5 RAM, it was no surprise to see the AtomMan challenge for top position in the CPU-based tests from Cinebench and Geekbench. There's gaming capability, too, with a 3,455 score in 3DMark Time Spy backed up by a smooth 49fps frame rate at 1080p in *Shadow of the Tomb Raider* (albeit at its lowest graphical settings).

The AtomMan makes a faint whine in performance mode, however, so you may find yourself switching to the balanced or even energy-saving mode in more general usage. This massively reduces fan noise during regular use. The X7 Ti will remain more than fast enough for general duties, but with reduced wattage on tap the CPU can't hit its peaks when pushed (Geekbench dropped by around 5%). I expected frame rates in games to drop, too, but in fact *Shadow of the Tomb Raider* played equally well.



The Ultra 9 185H also includes an NPU, but it isn't powerful enough to meet Microsoft's Copilot+ PC criteria and only gives mild acceleration in the handful of software titles that support NPUs. One example is Microsoft's Camera app, as unusually the AtomMan X7 Ti includes a 1080p webcam.

Quality is poor compared to modern laptops but passable for video calls, and that NPU means you can blur your background without calling on the CPU. Also bear in mind that even when you place the X7 Ti on its stand, which allows you to angle it from flat to just beyond perpendicular (around 0° to 100°), the angle is unlikely to be angle.

With an IR sensor, the AtomMan can recognise your face and log you into Windows. And don't worry about privacy, as there's a physical cover you can slide over. This sits alongside the power button (complete with fingerprint sensor) and full-size SD card slot at the top, with a

mic, 3.5mm jack, two USB-A ports and a

USB-C 4 port on the right. But the main and eclectic

port horde sits on the left: HDMI, DisplayPort, two USB-A, USB-C 4 and two 5GbE connectors. The power connector also sits here, so the result is inevitably a forest of unsightly cables.

One more port is worthy of note: an OCuLink connector. Minisforum

sells its DEG1 external GPU docking station for £95, into which you can slot any graphics card you like. But despite the X7 Ti's relatively tall 49mm height and generous 145 x 145mm footprint, there's no room

for a 2.5in SATA drive. The extra room inside is taken by a huge heatsink, which you need to remove to access the RAM and SSD sockets; you can add a M.2 2230 PCI-E 4 SSD to accompany the supplied 1TB M.2 2280 SSD.

Thankfully, fast external storage via those USB-C 4 connectors can come to your rescue. In fact, add a graphics card and fast external storage – if you have the budget you can even upgrade the RAM from 32GB to 96GB – and you have something of a monster on your hands. Perhaps those twin 5GbE ports can be called into action too.

The big question is whether it's worth the money. While the Minisforum Venus UM790 Pro looks positively dull in comparison to the AtomMan X7 Ti, its AMD Ryzen 9 7940HS pushed the Core Ultra 9 185H close in CPU benchmarks – and, as a package, the Venus was actually faster in PCMark 10 by a distance. While the screen is a cute extra, it's by no means vital, so we know which we'd choose.

ABOVE The 4in touchscreen lets you see key running stats at a glance

The 4in touchscreen gives you an at-a-glance summary of CPU, GPU, RAM and SSD usage and temperatures

LEFT A stand allows you to position the AtomMan at an angle

BELOW There's an eclectic selection of ports on the sides



Minisforum Neptune HX100G

Much larger than rival “mini” PCs, but in return you get the best gaming chip here by a distance

SCORE ★★★★★

PRICE £741 (£889 inc VAT)
from store.minisforum.uk



Is the Minisforum Neptune HX100G really a mini PC? It certainly won't fit into everyone's notion of such a thing, with a comparatively monstrous footprint of 205 x 203mm. Add a 69mm height and that means its 2.87l volume is three or four times that of its rivals; to put it in all-important chocolate terms, the HX100G is very nearly the size of a Quality Street tin.

As this PC is made by mini PC specialist Minisforum, though, we guess it's a mini PC by definition, and unlike the PCSpecialist Torpedo Ultra R (see p52) we allowed it into this Labs. And it immediately became clear that the extra volume made a huge difference, because it allows for more powerful components, along with an expansive cooling system.

In particular, this is the only mini PC to include a discrete graphics chip. Not a separate graphics card, but AMD's powerful Radeon RX 6600M GPU that's integrated onto the motherboard. This powered the Neptune to a chart-topping 8,599 in 3DMark Time Spy, which is why this system returned 110fps in *Shadow of the Tomb Raider* at 1080p and highest settings. That dropped to a more modest 32fps at 4K, but it shows there's true 3D acceleration here – which is useful for creative software too.

We weren't at all surprised to see the Neptune a significant chunk ahead of all its rivals in PCMark 10's Digital Creation section as a result, with its 13,758 score almost 50% faster than the Minisforum Venus UM790 Pro. That's noteworthy because the



Neptune includes a lesser processor, the AMD Ryzen 7 7840HS, compared to the UM790's 7940HS.

Mind you, this is where cooling can make a difference. Even though the 7840HS can't reach as high a boost frequency as the 7940HS, the Neptune HX100G beat its sibling in all four of

our CPU tests: Cinebench and Geekbench, single core and multicore. It really is a stupendously fast mini PC, the quickest here by some distance.

That's reflected in its idle and peak power draws, however, which might just have you reaching for a solar panel brochure. Even when idling the system demands 20W, and that hit a positively greedy 263W when we pushed all its cores and the GPU to their limits. To put this into context, though, a typical gaming PC will want three or four times that much electricity, so it may be far more efficient than the five-year-old tower PC it replaces.

If you're willing to fight past eight crosshead screws and work out how

ABOVE The Neptune HX100G is the biggest – and the fastest – mini PC here

Compared to 'true' mini PCs it's expensive to buy and run, but in return you get an extra dimension of usability

LEFT The design is tough but unexciting

BELOW The chassis has space inside for a second M.2 2280 SSD

to prise the lid off, there's room to add to that load by adding a second M.2 2280 SSD or replacing the heatsink-covered RAM – the price includes a 1TB SSD and 32GB of DDR5-5600 memory. What you don't get, a little surprisingly, is any space for a 2.5in SSD. The final replaceable component

is a MediaTek MT7921 M.2 Wi-Fi card, which is now showing its age as it only supports Wi-Fi 6 and Bluetooth 5.2.

External connectivity is more positive, thanks primarily to two USB-C 4 ports. These sit at the rear and open up an easy way to add fast external storage or screens (up to 8K at 30Hz), while a pair of HDMI 2.1 connectors make a four-screen setup possible. A single 2.5GbE connector and three USB-A ports round out the rear selection. The front is less exciting, with one USB-A and one USB-C port, both stuck at 5Gbits/sec, alongside jacks for a mic and headphones.

We're not sure if we'd call the design exciting, either. It's made of a carbon and resin composite, and while that lends it a tough air – we wouldn't be too worried if we dropped the 1.45kg Neptune during our travels – it's not the most eye-catching PC you'll see. It does look more striking when placed in its stand, however.

Setting such vain factors aside, we like the Neptune HX100G. Most of the day it will sit there quietly, with its fans only called into action when it's time to play games or stretch the silicon. Yes, compared to “true” mini PCs it's expensive to buy and run, but in return you get an extra dimension of usability. If you're looking for a compact system that can do it all, the HX100G is a fantastic choice.





Minisforum Venus NAB9

Not the fastest mini PC on the block any more, but there's no arguing with the NAB9's value for money

SCORE ★★★★★

PRICE £324 (£389 inc VAT)
from store.minisforum.uk



The Minisforum Venus NAB9 is the cheapest mini PC in this group test, but you wouldn't know that from looking at it – or using it. That price includes a Core i9-12900H processor, which may be two years old but is still a high-performing choice: while scores of 2,358 and 10,819 put it near the bottom of our Geekbench 6 graph, that's only because it's in such high-flying company. The NAB9's scores would have been considered excellent two years ago, and with 20 threads split across six P-cores and eight E-cores it remains a fine choice for demanding tasks.

It's more than capable of light gaming, too. *Shadow of the Tomb Raider* is now a few years old, but it demands far more of graphics chips than many popular games – we're particularly thinking of *Fortnite* and *Minecraft* – so for the NAB9 to average 37fps in its benchmark at 1080p is a fine achievement, albeit at the game's lowest graphics presets. Its result almost halved to 19fps when we pushed these to their maximum.

Including a pair of 2.5GbE ports not only brings redundancy, it also makes the NAB9 more attractive to those looking to build a custom NAS system or a home server. At this point the amount of storage becomes crucial, so it's a shame that Minisforum has sold out of the 1TB version on its UK website and that there isn't a second M.2 storage slot. Still, there's room for a 2.5in SATA drive within the chassis, and uniquely you can "pop off" the cover by pressing down on it. This reveals all



ABOVE The NAB9 is a lot cheaper than it looks – and performs

the internal space, so if you ever want to upgrade the two 8GB DDR4-3200 SODIMMs or M.2 Wi-Fi 6 card – and we wouldn't blame you on either count – it's simplicity itself to do it.

You aren't so blessed with external connectivity. There's a USB-C port to accompany the two front-mounted USB-A ports, but it's only capable of 5Gbits/sec transfers. Two more

USB-C ports sit at the rear, but one of them (next to the two USB-A ports) is only for output to a screen. A further two HDMI ports means you can connect up to four screens simultaneously, which is impressive for the price.

We were also impressed by how little sound the NAB9 made. Air flows through the sides and up through the base (which has numerous slots), and evidently that's enough when fiddling around in Windows 11 Home or browsing websites. It's almost needless to say,

but the Core i9 processor proved a snappy companion for lighter tasks such as typing in Word or watching Netflix – and again the fan rarely sprang into action. The only time we noticed it was when playing games or pushing the CPU in multicore benchmarks.

So we were a little surprised to see that this mini PC was one of the greediest when sitting idle, grabbing 13W of power at minimum. That's twice as much as the UM790 Pro and Geekom's Mini IT13 and XT12 Pro, so even though

With 20 threads the Core i9-12900H CPU remains a fine choice for demanding tasks. It's more than capable of light gaming, too

the NAB9 will likely cost far less to run than the PC it replaces, there are bigger savings to be made elsewhere. When we factored in its high 83W peak consumption, the NAB9's five-year running cost totalled £78, compared to £55 for the UM790 Pro.

Our calculations were based on eight hours' use per day. With £160 separating the NAB9 and UM790, that means you would have to keep both systems running all day for around ten years before the total cost of ownership matched. All of which underlines what great value the Venus NAB9 is.

We only hesitate to give it a Recommended award because, despite the low price, 16GB of RAM and 512GB of storage feels less than ideal for an otherwise powerful system – and the sole upgrade route that avoids replacing the RAM and SSD is adding a slow 2.5in SATA drive. Despite this, we like the NAB9, so if your budget really can't stretch any further, then buy it. Just note that Minisforum is clearly running out of stock, so you may need to make the decision sooner rather than later.



LEFT The cover can be opened by simply pressing down on it

BELOW Twin 5GbE ports make the NAB9 a good choice for a NAS or home server



Minisforum Venus UM790 Pro

Head and shoulders above rivals for value and matching them for speed, the UM790 is an obvious winner

SCORE ★★★★★

PRICE £458 (£549 inc VAT)
from store.minisforum.uk



Judged on looks alone, there's every chance the UM790 Pro would win the award for world's most boring mini PC. The only glimmer of excitement on this square black box is the green LED that lights up to show you it's working. But then you might notice the "USB4" sitting above the pair of USB-C ports, and this opens up options such as 10GbE networking and external GPUs; you can even power this mini PC through them.

All four USB-A 3.2 Gen 2 ports are relegated to the rear, kept company by a relatively mundane pair of HDMI ports and a single 2.5GbE connector. Things become more interesting on closer inspection.

Pick up the UM790 Pro and you'll appreciate its solid all-metal construction, with honeycombed sides to allow a glimpse inside and maximise airflow. A grille dominates the bottom, again to keep air flowing, and the major benefactor sits below a modest heatsink: the AMD Ryzen 9 7940HS processor. Now a year old, this was AMD's first mobile chip to include an NPU, and it doesn't meet Microsoft's Copilot+ PC criteria.

Far more importantly, though, it's fast. The eight high-performance cores, based on AMD's efficient Zen 4 architecture, pushed it to excellent scores in all our tests, to the extent that we would be happy to use this for demanding tasks. It always helps to have 32GB of RAM in support, but you can buy the UM790 Pro with 64GB of RAM for an extra £110. Both specs now include a 1TB PCI-E 4 SSD, but our test system included a pair of

256GB SSDs. Lower-capacity SSDs tend to be slower, so we would expect the retail version to achieve speeds that line up with the UM790's rivals.

In fact, because this Minisforum PC includes two M.2 2280 PCI-E sockets, internal storage is one of its big advantages compared to, say,

the Geekom A8. Without too much effort, albeit a little extra expense, you could be in charge of a Ryzen 9 system with 64GB of RAM and 4TB of extremely fast SSD storage.

You can even use them in RAID configuration, with Minisforum claiming that it has seen speeds of

almost 13,000MB/sec reads and 12,500MB/sec writes.

Minisforum could learn from Geekom when it comes to easy access, though, with the four crosshead screws blocked by plastic feet covered in adhesive. Also be careful not to dislodge the duo of Wi-Fi antenna cables that are connected to the base, and all too easy to dislodge



ABOVE Honeycombed sides allow you to glimpse inside and help maximise airflow

accidentally. A third and easy-to-remove cable feeds the single fan, but this kicked into action only when we were pushing the UM790 Pro hard in benchmarks. Generally, this PC proved to be one of the quietest systems on test.

That was reflected in its low idle

power consumption of 6W, but start using all those cores and the graphics acceleration and it ramps up to 81W. But it's worth doing so. The Radeon 780M is a great integrated mobile GPU,

helping the Venus break the 30fps "playable" average in *Shadow of the Tomb Raider* at 1080p and its highest settings. Overall, you could argue that this is the fastest true mini PC here; the discrete GPU in the Minisforum Neptune HX100G proved faster, but it's more than three times bigger, too.

We've already touched upon this system's solid portfolio of physical ports, with the pair of USB 4 connectors lifting it above most rivals, but at this price it's also great to see Wi-Fi 6E rather than standard Wi-Fi 6. It's an Intel Killer AX1675x M.2 card, and while that's probably more than good enough for the lifetime of this mini PC you can replace it.

All of which makes us marvel at the UM790 Pro's price. Yes, it's chunkier than the Geekom 8, which also comes with a more recent AMD processor, but it's also £250 less. As we mentioned in our buyer's guide (see p82), that's reflected in a two-year warranty where you will have to pay for outgoing courier costs (unless you spot a problem within seven days), but that isn't enough to stop this miniature wonder scoop our Labs Winner award.

The USB-C 4 ports open up options such as 10GbE networking and external GPUs; you can even power this mini PC through them

LEFT The design may be understated, but there's power within

BELOW The UM790 Pro comes with two USB-C 4 ports, as well as the usual selection





MSI Cubi NUC 1M

If you're buying for business, this well-built option comes with a load of management-friendly features

SCORE ★★★★★

PRICE £458 (£549 inc VAT)
from scan.co.uk



When Asus and Intel signed on the dotted line in October 2023, agreeing that Asus would take on development of the NUC line, it's romantic to imagine someone in MSI HQ banging their fist on the table, commanding the lawyers to find a loophole: surely it could create NUCs, too? And so, apparently, it can, and if it can keep up this quality of workmanship we're more than happy for MSI to join the NUC party.

It takes a more eco-conscious approach than its rivals, emphasising the fact that 42.9% of its plastics are PCR and gaining EPEAT Silver status for the range. It helps that MSI uses a mix of solar panels on its factory roof and buys energy from renewable sources for almost all the rest. This is good news for businesses who need to show they buy responsibly, and MSI also hopes to tempt IT managers with the promise of network segmentation, redundancy and load balancing thanks to two 2.5GbE ports.

You're also paying a little extra for Thunderbolt 4 support, and the guarantees for performance and compatibility that it confers, with two ports sitting at the rear. You can use one of these to power the Cubi, or rely on the usual DC input. And there are two other neat and unique features when it comes to power: the first is that there's an external power switch (which sits on the end of a short cable), so if you decide to hitch this mini PC to the back of a monitor then you can switch it on without reaching around the back. And there's even better news if you



ABOVE The Cubi NUC 1M is well suited to business environments

M.2 SSD, albeit of the 2242 format rather than 2280, and there's room to mount a 2.5in SATA SSD as well. It's again easy to replace the CR2032 battery and M.2 Wi-Fi 6E card, should that ever become necessary.

MSI can also take heart from this computer's projected running costs,

which are – albeit by the narrowest of margins – the lowest here this month. It's also quiet. Put your ear against the chassis and you can hear the faintest of whirrs from

the fan inside, and they rarely go above this level. Want another reason to put this in an office? How about the fact it comes with Windows 11 Pro rather than Home? MSI makes much of its testing and reliability, too, and has recently set up a UK-based service centre to speed up repairs. However, the company told us that it anticipates that most businesses that invest in its Cubi NUC 1M systems will have spares in stock, such is their affordability.

Note that it comes in barebones options with a choice of CPUs: Core 3 100U (£349), Core 5 120U (£449) and Core 7 150U (£519). Or you can buy complete systems, with the Core 5 version costing £649 and the Core 7 edition £769 (it includes 16GB of RAM and a 1TB SSD to the 8GB/512GB combo of its siblings).

Not that the MSI looks such great value next to the Minisforum Venus UM790. For the same price, you can buy a far quicker system with double the storage, and for home enthusiasts it's certainly a better choice. But this isn't a mini PC for enthusiasts, and whether for reliability, customer support or features, this is the best business option on test.

buy compatible MSI monitors, which you can configure to turn on the Cubi at the same time.

In performance terms, our Core 3 100U configuration is really only suited to light office tasks. You can see that in its PCMark results on p94: it slumped to 5,326 in the Digital

Creation test, but achieved solid results in both the Productivity and Essentials sections.

As this implies, the Core 3 100U is a weak performer in multicore tasks, and it wouldn't even run the Cinebench 2024 test. Don't expect much help from the GPU, either, with its 1,153 score in

3DMark Time Spy made to look respectable only thanks to the PC Specialist Azena R (which also targets business buyers).

The Cubi would have scored higher if MSI had fitted a second 8GB SODIMM, but this is easy to add yourself as it's ludicrously easy to remove the back. Not quite tool-less like the Asus NUC 14 Pro+, but close. You'll find space inside for a second

MSI hopes to tempt IT managers with the promise of network segmentation, redundancy and load balancing thanks to two 2.5GbE ports

LEFT MSI's mini PC has strong eco credentials

BELOW There are two Thunderbolt 4 ports at the rear, alongside two 2.5GbE sockets



PCSpecialist Azena R

A solid but noisy rival to the slimline corporate desktops you'll find from Dell and co, and notably cheaper

SCORE ★★★★★

PRICE £499 (£599 inc VAT)
from pcspecialist.co.uk/reviews



It may not look like it, but the PCSpecialist Azena R has much in common with the MSI Cubi NUC 1M. This is a mini PC squarely aimed at businesses, and more particularly it's designed to attach to the rear of a monitor; it even integrates a mounting plate with four screw holes to make this process easier. Our only surprise was to see it ship with Windows 11 Home, but that's easy enough to upgrade to Pro.

You can also sit the Azena R vertically on the supplied stand, which takes advantage of its slimline design. At 1.4 litres it's larger than a typical mini PC, but it's one of the slenderest here at 38mm (although the backplate adds around 5mm) so can easily slip into a narrow space. This then gives you easy access to the numerous front-mounted ports: three USB-A, one USB-C, plus a trio of 3.5mm jacks for headphones, mics and call-centre-style headsets.

Round the back you'll find a further two 3.5mm jacks, this time for mic in and line out. These sit alongside two USB-A 3.2 Gen 2 ports, two USB-A 2 ports, a 1GbE connector and two video outputs: one HDMI, one DisplayPort. Wi-Fi 6 and Bluetooth 5.2 come as part of the package via an Intel AX201 M.2 card, with the metal chassis acting as the antenna.

Removing two crosshead screws (non-captive) allows you to slide off the top of the chassis to reveal the Asus Pro H610T D4 motherboard within. You'll also find a chunky heatsink, cooled by a noisy fan, covering the CPU and the 16GB of DDR4-3200 RAM. If you want to upgrade this, you'll have to

remove the heatsink, but it's far easier to replace the supplied 1TB SSD. The motherboard's M.2 2230 slot is filled with the previously mentioned Wi-Fi card, but you can add a 2.5in SATA drive via the supplied storage caddy.

The Asus Pro motherboard should be a reassuring inclusion for IT managers, as it's part of Asus' business range and comes with the promise of long-term

support, a 36-month lifecycle and easy remote management thanks to the Asus Control Center Express tool. Using this, an IT department can automatically update the BIOS overnight for a fleet of these PCs.

So the Azena R is a PC that IT teams can easily fall in love with. Whether users will, we're not so sure. The main reason stems from the fan noise, which was not only audible but varied from low to medium to high even when the PC was idling. This can be adjusted via utilities, but the out-of-box experience isn't great for those who are bothered by such things.

One reason for the fan whirring away is that a desktop rather than mobile chip sits inside. But if you were

ABOVE Despite the desktop CPU within, performance was merely middling

expecting the Core i5-14400 to leave its laptop brothers in the dust then get ready for a surprise: the Azena R's performance was distinctly mid-table, scoring 2,437 and 10,856 in Geekbench's single-core and multicore tests respectively. The only time it came anywhere close to the top of the table was in PCMark 10's

Essential tests.

While we wouldn't expect the Azena R to be used for games, its low scores in 3DMark Time Spy and *Shadow of the Tomb Raider* are more an indication that its basic

Intel UHD Graphics 730 won't be much use when it comes to GPU acceleration in any software that takes advantage. Not a problem in Microsoft Office apps, but this isn't a PC to choose for graphics work. Nor does the CPU have any AI-specific skills, as Intel is yet to introduce an NPU into its desktop range of chips.

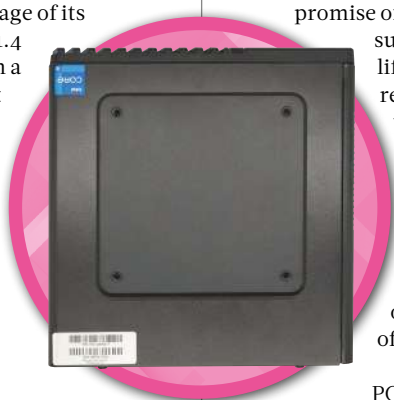
So, is the Azena R worth buying? Despite our criticisms, it does hold advantages over its corporate rivals: for instance, the Dell OptiPlex Micro Form Factor shares a similar design but costs almost £140 more for a near-identical specification (albeit with a vPro processor for easier management still). And although we like the MSI Cubi NUC 1M, if something goes wrong you don't have the same level of support that PCSpecialist provides – and it's easy to upgrade the three-year warranty to cover parts and courier costs.

It's not enough to make us recommend the PCSpecialist Azena R, especially as it's more expensive to run than rivals here, but it is something to bear in mind when making your buying decision.

The Azena R is a PC that IT teams can easily fall in love with. Whether users will, we're not so sure

LEFT An integrated mounting plate makes it easy to attach the Azena R to a monitor

BELOW There are numerous ports on the rear as well as the front of the PC





How we test

We focused on everyday speed with this selection of benchmarks, starting off with the CPU. Here, we used Geekbench 6.3 and Cinebench 2024 to test both single-core and multicore performance.

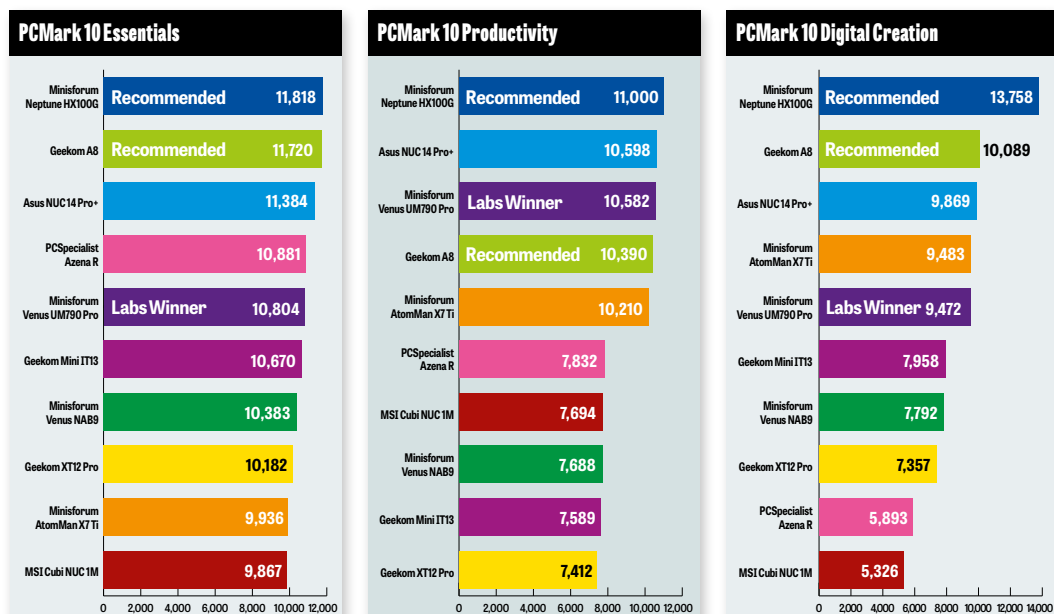
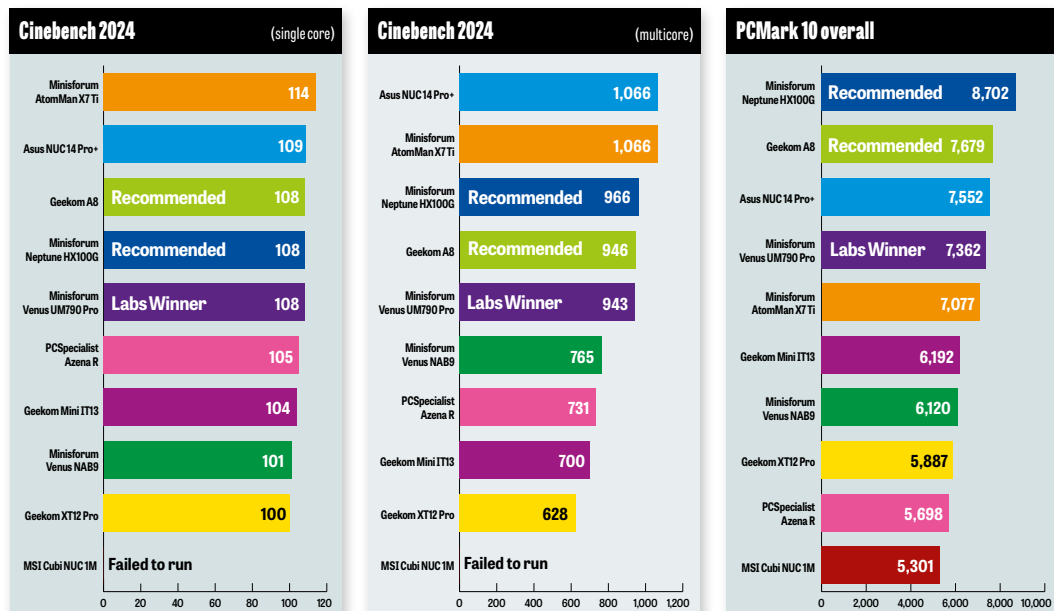
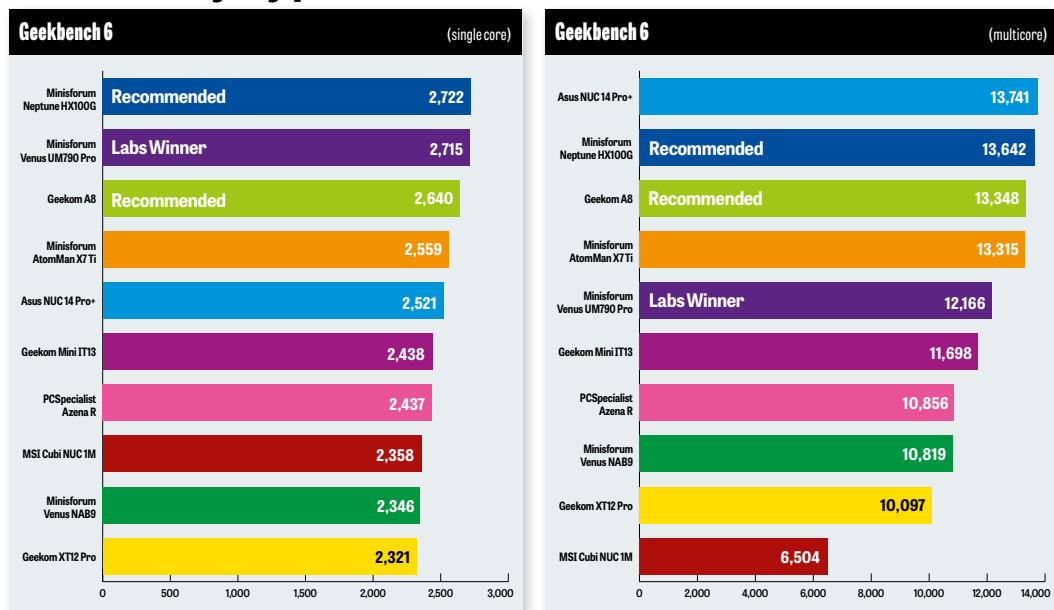
PCMark 10 is a more rounded test, as it places demands on all the core components: CPU, GPU, RAM and SSD. Anything above 10,000 suggests that the system will feel fast in the chosen task, but results of 7,000 or more indicate that the PC will cope fine.

Next we turned our attention to the GPU. As our results show, mini PCs as a category aren't a natural choice for gamers, but that doesn't mean that they can't play games at all. All but two of the test systems produced playable frame rates in *Shadow of the Tomb Raider* at 1080p, even if we had to drop to its lowest graphics settings. We also print scores for 3DMark Time Spy, which is a synthetic benchmark but provides a great at-a-glance score so you can compare systems' theoretical 3D acceleration. Not just for games: for any software that takes advantage of the GPU.

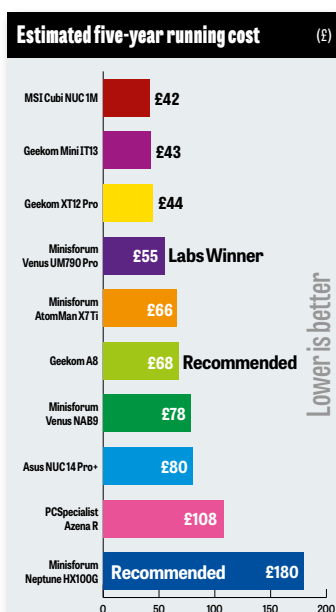
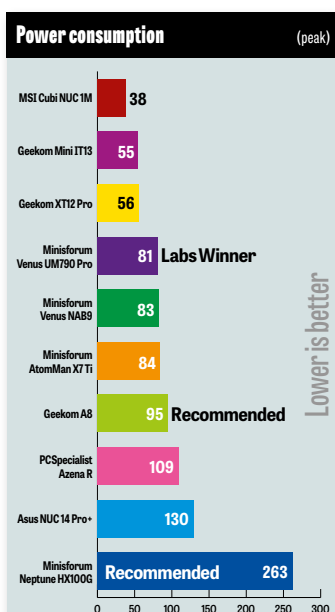
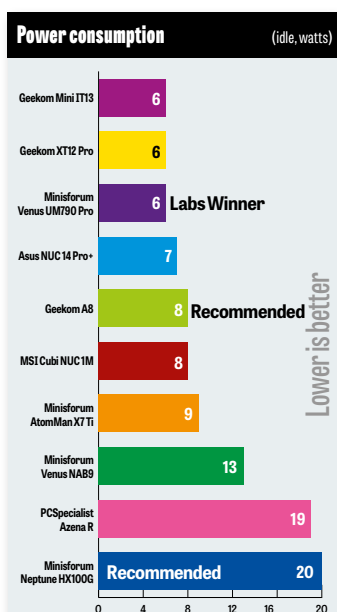
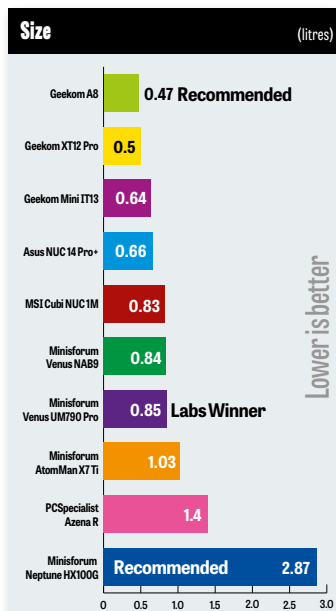
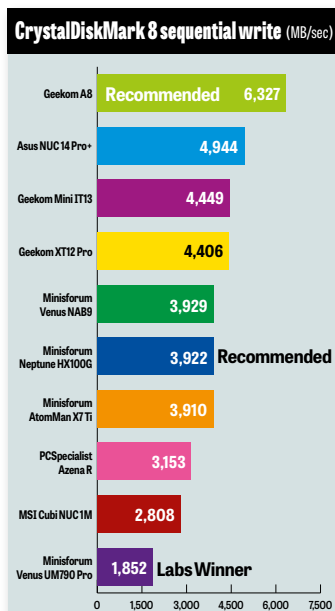
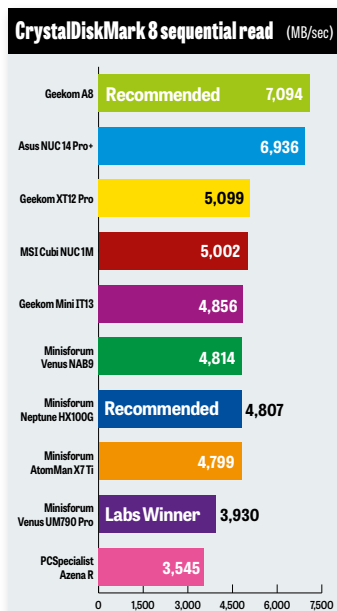
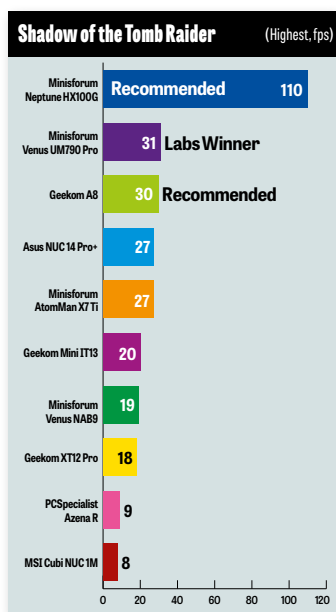
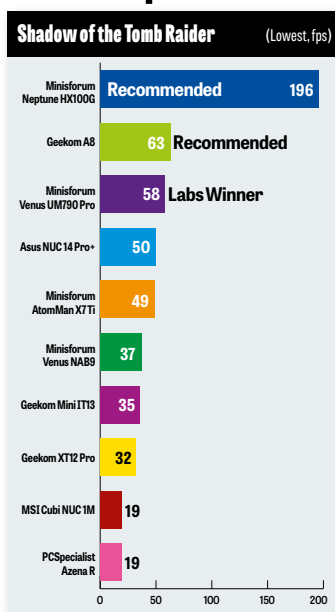
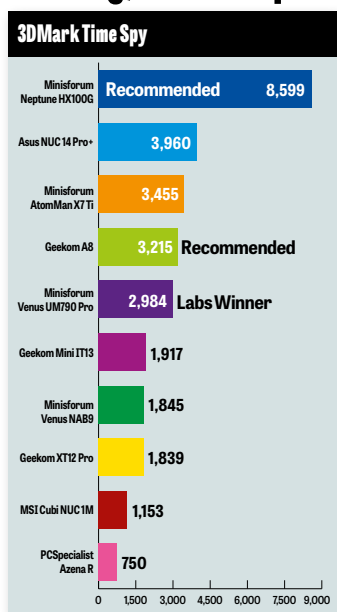
The CrystalDiskMark scores show basic straight-line speed for copying and writing data. As we note in the review of the Minisforum Venus UM790 Pro, its results are held back by the company shipping 256GB SSDs in our rig; the 1TB SSD it ships with should be closer to its siblings.

Finally we come to power consumption and running costs, which we cover separately on p83. In short, we measure draw at idle and at peak (pushing all the CPUs and the GPU to their maximum), then extrapolate running costs over five years based on an eight-hour working day and the current 24.5p per kWh price for electricity. The results are an estimate, for guidance only, but it's a handy way to show the long-term impact of a few watts here and there.

CPU and everyday performance tests



Gaming, disk and power consumption tests



View from the Labs

There are certain of my colleagues who consider writing a Labs a penance. Not necessarily the writing itself – although I can tell you right now that there are only a handful of ways to describe a mini PC – but the mammoth task of sourcing all the different products, testing them and creating the detailed feature comparison table that I hope you find useful.

I've never looked at Labs like that. It's hard work, brutal in terms of invested hours, but in return you get something unique: a genuine overview of an industry. You start to see where companies skimp or invest, gain a better understanding of what "good" performance means, and start to see patterns. All of which sets you up for the next 12 months: next time a new mini PC lands on my desk, I have context.

While anyone reading this can't share the physical contact I've had with these computers – the crosshead screws I've had to wrestle out of their sockets, the fan noise, holding them in my hand – I've done my best to communicate those feelings in the reviews. And there's nothing quite like a set of graphs, showing devices tested under exactly the same conditions at exactly the same time, to reveal truths that are otherwise hidden.

As ever, it isn't perfect. I'm annoyed that Beelink didn't send in any computers for testing; its current marketing model appears to be sending computers to influencers rather than reviewers. And I'm greedy: I always want more PCs to review.

Still, I see this Labs as only the latest (but perhaps the most important) landmark on PC Pro's journey when it comes to mini PCs, which are an increasingly interesting sector. Expect more reviews to come as new products are released – including, I hope, from Beelink. ●



Tim Danton is PC Pro's editor-in-chief and a fan of all things small.

The Network

Practical buying and strategic advice for IT managers and decision makers

Buyer's guide

Endpoint protection 2024

You know what you need to do with your weakest security link: protect it. **Dave Mitchell** explains what to look for in endpoint protection software and reviews four candidates

Client devices, or endpoints, can be the weakest link in any data security strategy. It's not enough to rely solely on perimeter security solutions such as firewalls and UTM appliances, since flexible working practices mean that many devices are now outside traditional network borders and beyond their protection.

Regardless of whether they're using workstations, laptops or mobiles, a geographically dispersed workforce can present businesses with serious security challenges. Cybercrime is now a well-established and very profitable industry, and endpoints are frequently targeted because they're less likely to be properly protected and can offer an easy way into the company network for juicier pickings.

Endpoint protection software is the answer. It can keep workers safe from harm regardless of whether they're in the office, at home or on the road. There are plenty of products to choose from, and the good news for SMBs is that many are very affordable and easy to manage.

This month, we review four business-class products from some of the biggest names in the industry – Viper, Sophos, WatchGuard and WithSecure. They're all a good choice for budget-conscious SMBs, and we've tested them in the lab to help you make the right decision.

Cloud control

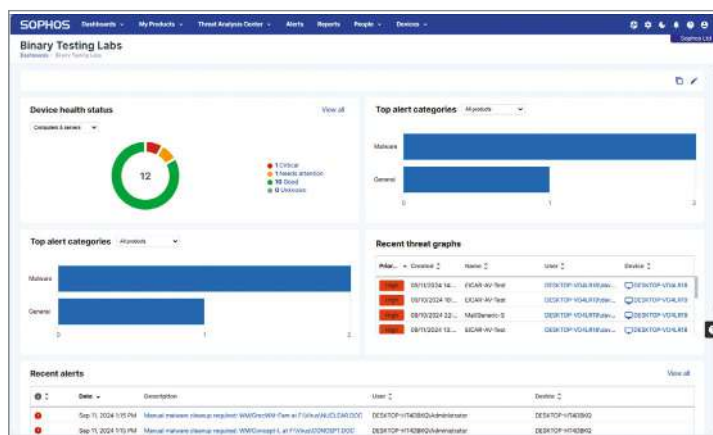
The four endpoint protection solutions we've selected for this guide are all cloud-hosted, and

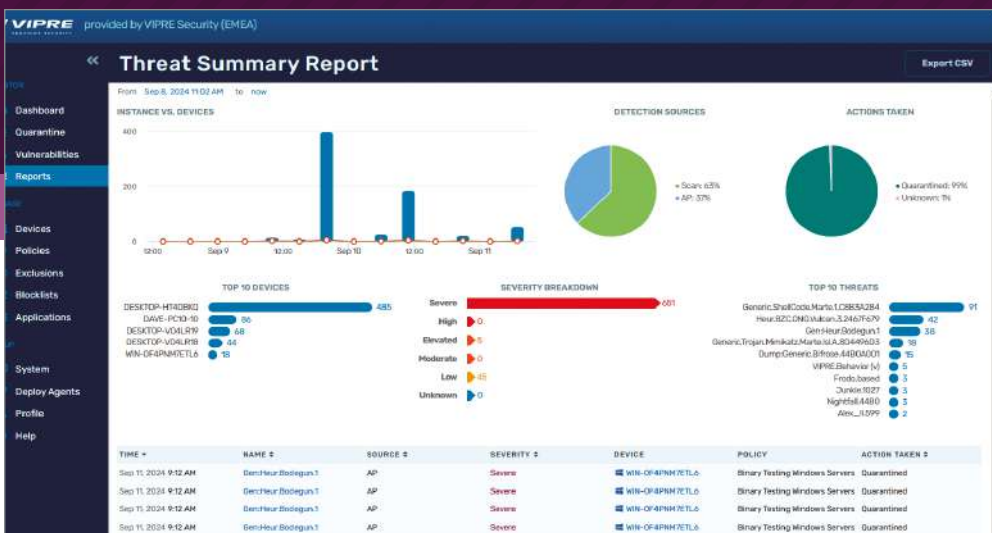
BELOW Sophos Central provides a clear picture of detected threats and device health

for good reason. Unlike on-premises solutions, they lend themselves very well to SMBs as they don't require additional investment in on-site hardware, are easier to manage, and are available in a range of subscription plans.

Deployment is simple. After creating your company cloud account, you use a secure web portal to centrally manage all endpoint protection regardless of the device's physical location. Workstation, server and mobile agents are pre-configured specifically to connect only to your account and take all their instructions from the cloud portal.

Agents can be distributed from a central location on the local network, while for remote workers most products offer facilities to email them a download link. Another feature to look for is the ability to import users from identity





management services such as Microsoft Entra ID or Active Directory.

Cloud-managed security policies are a powerful feature. They can assign instructions to agents that enable various protection features and, in most cases, a default policy is assigned to new devices so they're immediately protected from common threats. Custom policies are an essential feature, enabling specific functions for groups of endpoints such as software updates, malware protection and scheduled systems scans, and can also stop end users from disabling the agent.

Clown strike

The CrowdStrike fiasco may be consigned to yesterday's news, but the catastrophic consequences of a seemingly innocuous software update mean businesses must ask providers some tough questions. It seems ironic that endpoint protection providers promote a zero-trust approach to threat detection, and yet

businesses now have to ask if the vendors themselves can be trusted.

It would be foolish to assume that this will never happen again, so what can a business do to protect itself? Turning off automatic updates to malware signatures would leave you vulnerable and wouldn't have helped anyway as the global outage was caused by an inadequately tested agent update automatically pushed to Windows systems.

One solution is to set aside some test machines and use staged agent updates. Look for vendors that allow you to create different groups of endpoints and apply custom policies that ensure they receive updates first so you can monitor their impact before releasing them to critical systems.

Some vendors offer early access to agent updates so you can test them in advance of GA (general availability). This can be applied to your test systems with a policy that has the early release option enabled.

Ask the prospective vendor what their testing procedures are. We did precisely that during our reviews, with one vendor advising us that at least four hours prior to their

release, daily updates are tested in a staging area comprising thousands of devices.

Subscribe to survive

Most products are offered in a wide variety of subscription plans,

ABOVE Vire supports Windows and macOS endpoints

"Custom policies are an essential feature, enabling specific functions for groups of endpoints such as software updates"

ABOVE LEFT Some products allow you to isolate endpoints from the network

LEFT WatchGuard's EPDR provides threat analysis and recommendations for remediation

and we recommend carrying out a survey of company devices first to get a clear picture of what workstations, servers, laptops and mobiles need protection. The best providers are transparent about pricing with most offering flexible subscriptions based on the number of devices with substantial discounts available if you purchase longer periods.

Some require separate modules to be purchased for each type of device, whereas others are more flexible and offer universal licences that can be assigned to any device. Mobile protection requires more research; some vendors include them in their standard device count, while others require a completely separate component to be purchased. One product in this guide doesn't support them at all.

Other features to look for are integral application and device controls. Products that offer these let you block certain types of apps from being run on endpoints and prevent company data from being copied to removable media.

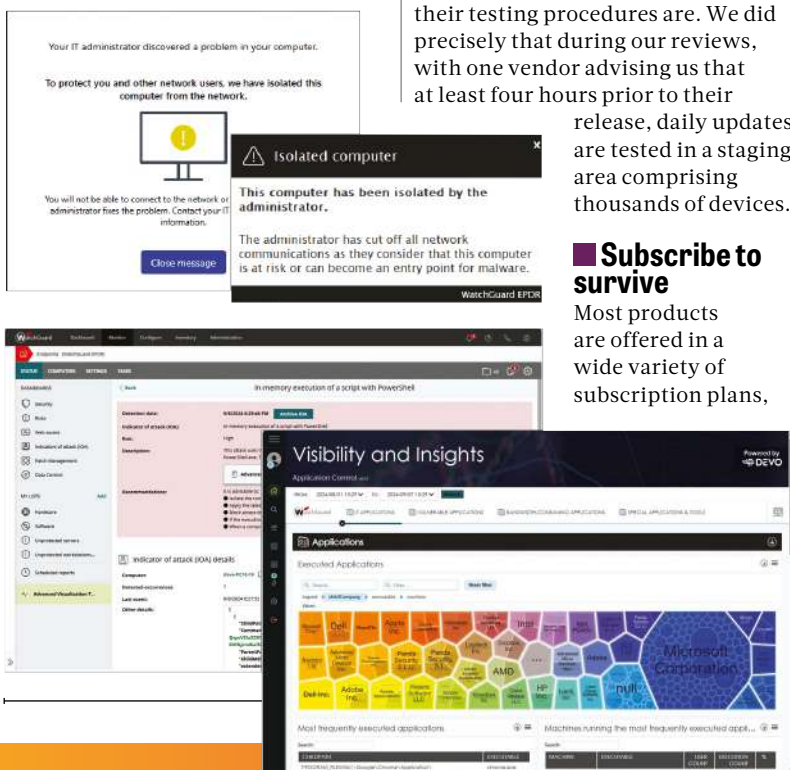
If your users will be handling

sensitive or confidential information, then data leak prevention (DLP) should be on your shopping list. Some vendors include this in their standard

subscriptions and allow you to create rules that examine the data or files being sent. These will be blocked if they contain personal information or sensitive data such as credit card numbers and bank account details.

To get a clearer picture of the threat landscape, consider adding endpoint detection and remediation (EDR) services to your subscription. EDR provides higher-level functions such as threat intelligence, incident forensics and automated responses to malware activity. It also alerts you to suspicious events and provides a full analysis so you can see clearly what happened and which devices have been compromised.

The consequences of a cyberattack can be catastrophic for SMBs, making endpoint protection an essential investment. Not all solutions are the same, and the four products we've chosen are all available as fully functional, time-limited trials so you can test them first.





Sophos Intercept X Advanced

Cloud-hosted endpoint protection at its best, with great security features and a classy web portal

SCORE ★★★★★

PRICE 100-199 users, £48 exc VAT each per year from enterpriseav.co.uk

Sophos' business endpoint protection solutions deliver an incredible range of features for the price, all accessed from one of the smartest cloud management portals around. Its portfolio starts with the Intercept X Advanced on review, which delivers complete workstation and server endpoint protection. The XDR version adds endpoint detection and response (EDR) services, or you can hand all the hard work over to Sophos with the managed detection and response (MDR) option.

Everything Sophos has to offer is managed from its Central cloud portal, which has had a major redesign that makes it even easier to use. All the main menu options have been moved to the top for faster access, and you can create a range of custom dashboards using a choice of widgets for the latest threats, endpoint health and alerts.

Choosing the portal's Endpoint menu option transports you to a main dashboard with an overview of your security posture. Agents for Windows and macOS systems can be downloaded from the portal and placed in a central distribution location, or you can email links to users that can be imported into Central from Microsoft Entra ID or Active Directory.

The agent takes five minutes to load and protects endpoints immediately by grabbing a set of predefined security policies. There's plenty on offer: Sophos provides separate policies for threat protection, web content filtering, removable device and application controls, data loss prevention (DLP) and the Windows firewall.

It's worth mentioning that Sophos offers an Intercept X Essentials version for small businesses. This has a reduced feature set, supports the base threat protection security policy and has a yearly cost of around £38 per seat for 100-199 users.

Intercept X Advanced allows you to clone base policies, customise them and apply them to users or computers. Along with the requisite real-time scanning, the threat protection policy enables live protection that uses the SophosLabs threat database to check suspicious files, AI-based deep learning to defend against unknown malware, and adaptive threat protection, which detects attacks and elevates endpoint security by blocking all potential threats.

Ransomware protection comes courtesy of the CryptoGuard feature. This detects files being opened for editing, places a temporary clean

ABOVE Sophos delivers tough endpoint protection services



"Sophos Intercept X Advanced is at the higher end of the price spectrum but it delivers an unbeatable range of tough security measures"

copy in a proprietary cache on the client's local drive and automatically rolls the file back to its original state if malicious encryption activity has been identified.

Sophos doesn't pester you with alert avalanches when threats are detected; if the agent successfully cleans up malware, it quietly posts the event in the dashboard and the relevant report section. Only when we created malware outbreaks on our Windows 10/11 clients did Central send immediate email warnings and place high alert entries in the portal.

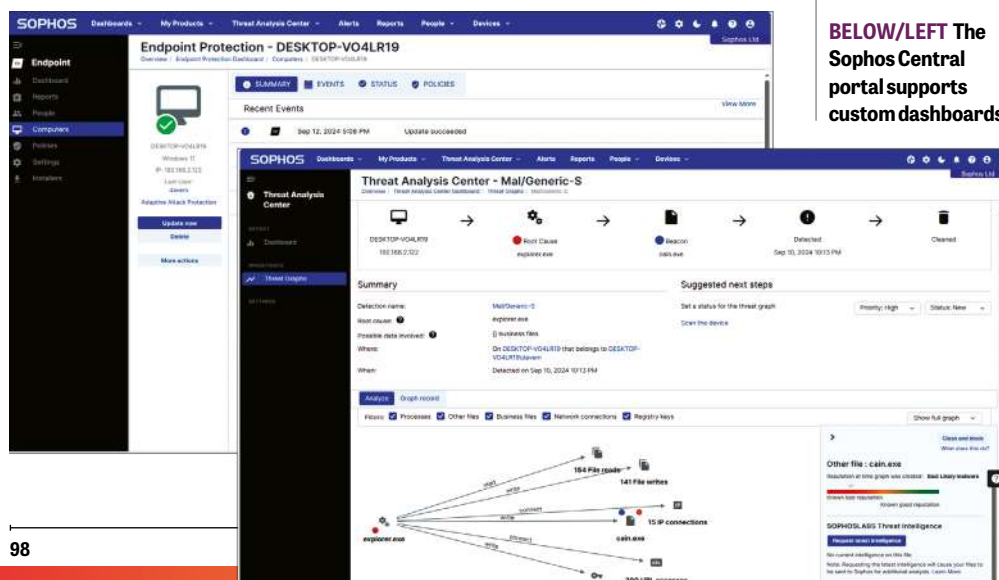
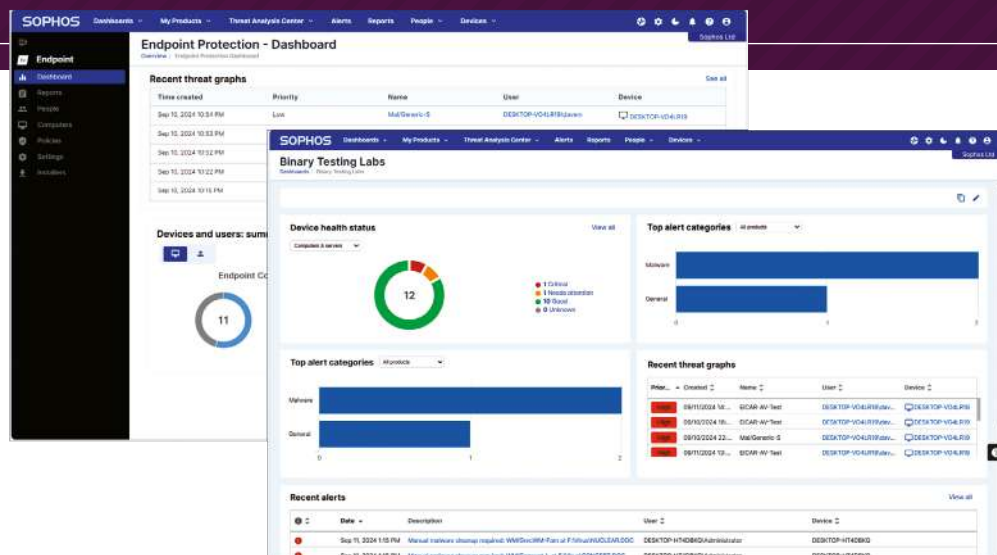
Select an event in the portal's threat analysis centre and you can view everything that happened on the endpoint, receive remediation advice and block the threat with one click. Upgrade to the XDR version and you can create custom threat cases, see deeper malware analysis and threat intelligence, and isolate endpoints.

Web control policies provide 48 URL categories to block or allow, while DLP policies are used to stop sensitive information such as banking details from being transmitted. Application control policies have nearly 240 predefined apps, and when we applied one to block FTP clients, users were denied access and received pop-up warnings when they tried to load them.

Sophos Intercept X Advanced is at the higher end of the price spectrum for endpoint protection but it delivers an unbeatable range of tough security measures for your money. Deployment is a breeze, the multitude of security policies make it highly flexible, and the Sophos Central cloud portal is peerless.

REQUIREMENTS

Windows 10/Server 2016, macOS 12.4 upwards, Linux servers. **Central Mobile Standard:** iOS 11, Android 5 upwards, 25-49 users, £35 each per year exc VAT



Vipre Endpoint Security Cloud

A very affordable and efficient endpoint protection solution, but it only supports Windows and Mac systems

SCORE

PRICE 25 devices, from £500 exc VAT per year from vipre.com

SMBs seeking uncomplicated endpoint protection will find Vipre's Endpoint Security Cloud (ESC) a worthy contender. This cloud-hosted service is easy to deploy and is great value, costing far less than most of the competition.

Security features haven't been compromised in the search for value. ESC offers file, web and email anti-malware scanners, AI behavioural analysis to counter zero-day threats, web content filtering, a client firewall, intrusion detection and a patch service for third-party apps. The only downside is its limited platform support: Vipre offers endpoints agents for Windows and macOS but nothing for Linux, Android or iOS devices.

We found the ESC web portal easy to navigate and used its deployment tool to email links for the agent installer to our users. You can also download and distribute the files yourself, which take around seven minutes to install, link up with your cloud account and pull down updates.

Protection is instant. Clients initially receive a base security policy with all malware scanning services, malicious URL blocking and active protection enabled. Vipre provides

three pre-defined policies for workstations, laptops and servers, which you can clone and customise for your own security policies.

In the agent download page, you'll find an option for custom builds. If you've been supplied with a build code, you can download early releases of agents and test them before they go on to general availability (GA).

Policies provide plenty of controls for Windows clients. You can stop users interacting with or uninstalling the agent, activate the host intrusion protection service (HIPS) to detect suspicious activity such as code injections, define how frequently definition updates are installed, and set schedules for quick and full system scans. The latest Windows agent adds device controls to policies where you can monitor or block the use of removable, optical and portable devices such as mobiles.

Email protection is included as standard, with the ESC agent scanning attachments for malicious content and removing message links to known phishing sites. The price we've shown includes the web access control add-on, which offers 44 URL categories that can

ABOVE The portal provides detailed reports for all protection services



be blocked or allowed and be applied permanently or to a daily schedule.

Patch management sees minor improvements, with the list now including 132 supported applications (up from 91 in previous versions), although some are quite obscure, such as the SkillBrain LightShot and TechSmith Snagit screenshot tools. The module works well enough, however – after we ran scans on our clients, ESC reported back with a modest list of detected apps showing their current versions and if they were up to date.

Windows systems get the lion's share of security services, with macOS

clients only receiving a small subset. These policies include options to control local access to the agent settings, set scan schedules and enable active protection.

The portal provides a set of predefined report templates covering essentials such as detected threats, web activity and scan status. ESC doesn't offer any remediation advice, but the endpoint timeline feature could prove useful as it shows clearly how threats developed.

A feature that really impressed us was Vipre's incredibly fast reaction time to detected threats. After introducing malware to our Windows 10/11 clients, a warning was posted immediately in the portal with email alerts received only 20 seconds later.

Vipre's Endpoint Security Cloud scores well for ease of use and value, making it a good choice for SMBs that want affordable endpoint protection. The main focus is on Windows systems and application patching is basic, but it delivers a good set of features, is simple to manage and has a lightning-fast reaction to threats.

REQUIREMENTS

Windows 7/Server 2012 upwards, macOS 10.10 upwards

"A feature that really impressed us was Vipre's incredibly fast reaction time to detected threats"

BELOW/LEFT Vipre's web portal provides lots of information about detected threats





PRICE 101-250 seats, £39 exc VAT each per year from guardsite.co.uk

Available in fixed-term and subscription-based plans, EPDR is good value and includes web content filtering, removable device controls, encryption, Windows patch management and data control tools. It's managed from the same cloud portal as WatchGuard's Firebox UTM appliances, wireless access points and ThreatSync XDR service. If you want to try it out before committing, WatchGuard now offers a non-intrusive endpoint risk assessment service that evaluates and reports on your current security posture.

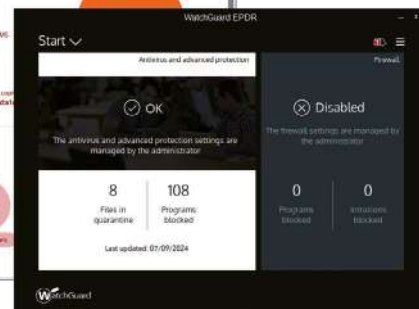
Policies control all security services, and protection starts

Web filtering has been updated, with EPDR now offering nearly 130 URL categories to block or allow, which include options for sites using generative AI. Anti-tampering policies can now protect computers booted into Safe Mode, and patch management sees improvements such as options to run update tasks first on computers designated as test systems.

The data control component is fully integrated into the cloud portal and uses profiles to determine what it should search for and monitor.



BELOW/LEFT
The cloud portal provides data about your endpoint security posture



Initially, you can set a policy to a passive Audit mode to gather information about app usage. A Hardening mode allows pre-installed unknown apps to run but blocks them from accessing external data sources, while the Lock mode fully protects against zero-day attacks and new malware strains.

The portal provides a wealth of views for all the components, with the security dashboard presenting graphs and charts for endpoint status, trusted apps, malware, exploits and PUPs. It shows all

unknown apps currently being cloud classified and if EPDR deems them to be safe, it instructs endpoint clients to allow them through.

When new threats are detected, the EPDR indicators of attack (IOA) service maps them to the Mitre ATT&CK matrix. The portal's IOA dashboard provides a complete breakdown of threat activity from reconnaissance and detected lateral movement to data exfiltration attempts, and selecting one of these options provides a full analysis and remedial recommendations.

EPDR is a smart cloud-hosted endpoint protection solution that combines great platform and mobile support with a wealth of security features. It's easy to deploy and manage, and will be particularly appealing to SMBs already invested in WatchGuard products.

Windows 7/Server 2012 upwards, macOS 10.10, Android 5, iOS 13 upwards, Linux



WithSecure Elements Endpoint Security

A top security choice for SMBs, with comprehensive endpoint protection, smart remediation and a good price

SCORE 

PRICE 100-499 devices, £37 exc VAT each per year from withsecure.com

WithSecure offers an impressive range of endpoint protection services, and it's been very busy integrating them all into a single unified cloud portal. Previously, there were separate EPP (endpoint protection) and EDR (endpoint detection and response) modules, but the Elements Endpoint Security (EPS) solution on review amalgamates them together under one extended detection and response banner.

The EPS portal is easy to navigate, and you'll find a lot more new features are in evidence. Accessed from the upper right menu, WithSecure's Luminen delivers AI-powered reporting services and, with one click, presents a detailed summary of security events.

You don't have to search for new features and updates either, as next to the Luminen icon is another one that drops down a list of all the things you need to know about. Platform support is another winner; EPS protects Windows and macOS workstations, Windows and Linux servers and Android and iOS mobiles, and includes patch management for Windows OSes.

For agent deployment, we could email links to users from the portal or download the relevant file and place it in a central location. Either way, it takes around four minutes to install and connect to your cloud account.

EPS provides preconfigured read-only security profiles that are assigned to devices on first contact, so protection starts immediately. We found it easy to create our own by cloning the predefined ones and tweaking them to our requirements.

Profiles manage real-time malware scanning, permit users to run manual scans, determine when automatic updates occur and schedule regular systems scans. Web protection services include reputation-based web page scanning, safe search enforcement, browser plug-ins and content controls with a list of 32 URL categories you can block or allow.

If you're worried about applying new updates to live systems, WithSecure has you covered with a feature that's always been in its profiles: early access to client software. Enable this option in a profile, assign some test systems to it and they'll get all updates at least a week in advance of general release.

ABOVE The BCD feature provides a breakdown of malware activity



"WithSecure's Luminen delivers AI-powered reporting services and, with one click, presents a detailed summary of security events"

BELOW The web portal keeps you posted on all threats

Along with controlling access to endpoint removable devices, profiles enable the Rollback feature for instant ransomware protection for Windows systems. Unclassified apps are tracked by EPS and, if they show suspect behaviour, it will close them and automatically roll back any changes they've made to files and the Registry.

The portal's security events page provides all you need to know about malicious activity and lets you add multiple recipients for email alerts. We tested its response to threats and after introducing genuine malware to our Windows 11 test clients, we

received email alerts in four minutes.

WithSecure's BCD (broad context detections) feature presents a filtered view of detected threats with a full analysis and process

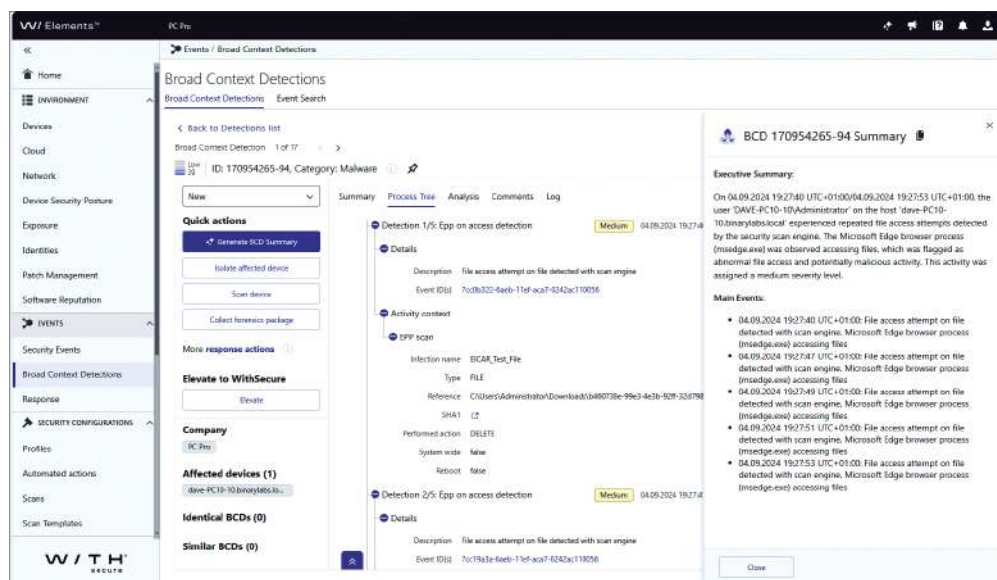
tree of suspicious events showing how the potential malware developed and what it interacted with. You can see affected systems, isolate them all with one click and, if you need more help, the event can be elevated to WithSecure's security teams.

You may not need to do this as Luminen also comes into play here, generating a summary of the main events and providing advice on remedial actions. Security teams that need a break may appreciate the optional co-monitoring service, where severe threats are automatically escalated to WithSecure's support teams. You can choose out-of-hours or full 24/7 cover.

WithSecure's Elements Endpoint Security delivers an impressive set of protection measures, all managed easily from its cloud portal. It supports a wide range of devices, Luminen provides valuable remediation assistance, and it's great value.

REQUIREMENTS

Windows 7/Server 2012, macOS 10.15, iOS 14.1, Android 8 upwards, Linux





Iperius Remote Professional 4.7

Uncomplicated cloud-hosted remote support that's easy to manage and incredibly good value

SCORE ★★★★★

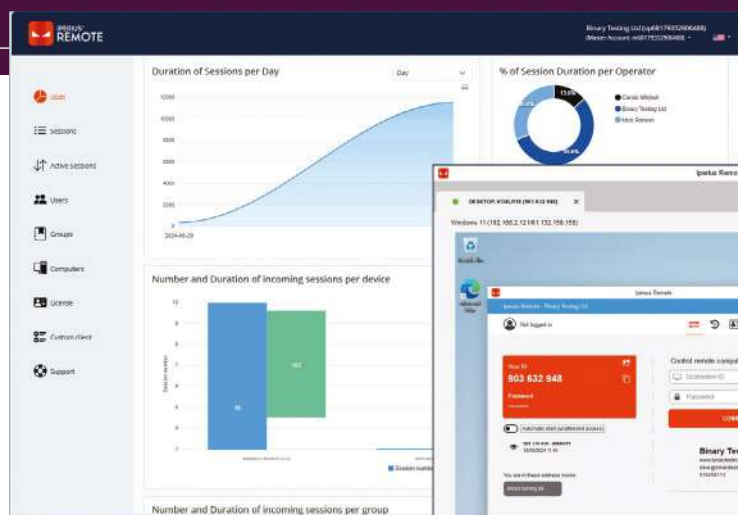
PRICE 10 concurrent connections, £30 per month exc VAT (billed yearly) from iperiusremote.com

Licence plans for business remote support products can be complex, but Iperius Remote cuts through the smokescreen as you simply choose the number of concurrent connections you want. Everything else is included, with all business plans supporting an unlimited number of devices and endpoints along with attended and unattended installations.

The Small plan costs £7 per month when billed yearly and supports two concurrent connections, while the Medium plan ups the session count to five, enables a multi-user mode plus mass deployment tools and costs £17 per month. We've reviewed the Professional edition, which starts at around £30 per month for ten sessions and includes a corporate rebranding service using customised clients. This can also be added separately to the other two plans.

Security is tight, with all plans delivering end-to-end TLS 1.3 session encryption and support for two-factor authentication. They all get an administration web portal, too, which allows users with the admin role to view all remote support activity and logs, create users and directly access computers.

Iperius Remote has a major redesign over the previous version and no longer uses Master and Client



accounts. Now you get one Master account that allows you to create an unlimited number of technician accounts and you can assign either Admin or User roles to them.

Client apps for Windows, macOS and Linux endpoints are provided and offer three installation choices. For attended access, the client is installed as a program and generates a unique nine-digit code and six-character password each time the user runs it.

For unattended access, it's installed as a service and requires the user to secure access with a personal password. On-demand access is covered as it's loaded as a run-time app. When the user closes it after the support session has finished, it leaves no traces on their computer.

To start a support session, the technician enters the ID and password of the remote system in their desktop app. Once connected, the technician's window shows the client's screen for full remote control, with a sidebar menu providing quick access to a basic set of tools.

File transfer opens a separate app with side-by-side windows showing local and remote storage devices for drag-and-drop copies, while connection switching allows technicians to share their screen with the client. Other options include running text chat sessions, remote printing, taking a screenshot, enabling session recording and adding the client device to the technician's address book, where they're listed in

their desktop app for double-click connections.

ABOVE Iperius takes access security very seriously



"Security is tight, with all plans delivering end-to-end TLS 1.3 session encryption and support for two-factor authentication"

Iperius provides excellent mobile support, with free iOS and Android apps. Technicians can use them on the move to provide remote support to any client device, and sessions to mobile devices deliver full remote control for Android phones or screen broadcasting for iOS mobiles and tablets.

The administration portal is accessed directly from the technician app and opens with a detailed display of all support sessions. It shows the total number of sessions per day or month, along with all sessions by their duration and by operator, device and group.

You can monitor active sessions and terminate them from the portal, while a full session log can be filtered by operator, group or device. Access to devices is controlled by placing computers in groups and allowing only specific technicians to see them.

We also used the corporate rebranding service to create custom Windows installation apps. These provide extra security and authenticity as you can enforce a global password, decide which support features are available,

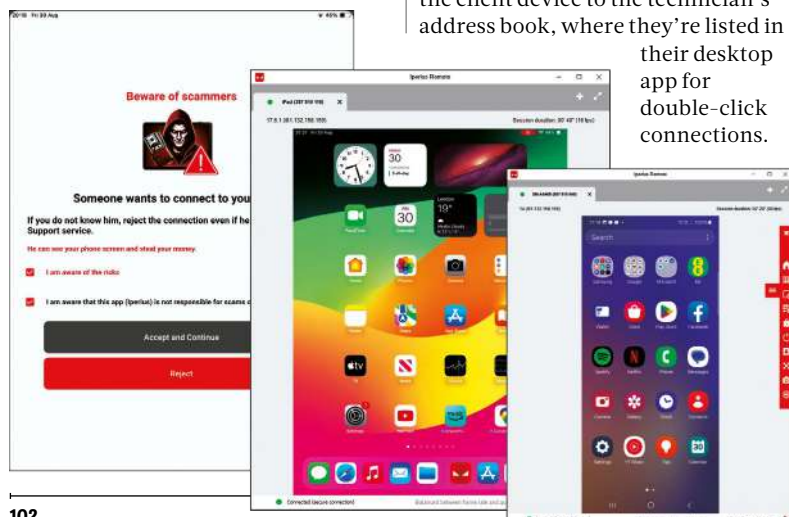
assign a logo icon to the executable file and add a company name, email and phone number, which appear in the desktop app main interface.

Iperius Remote isn't as sophisticated as some competing cloud-hosted support solutions but points lost for features are regained handsomely for value. Access security is good, the web portal provides plenty of information about support activity and the simplified licence plans are very affordable options for SMBs. **DAVE MITCHELL**

REQUIREMENTS

Windows 7/Server 2012, macOS 11, iOS 12, Android 6 upwards, Linux

LEFT The admin portal is very informative, and there's support for unlimited endpoints



Qnap TS-632X

This Amazon-powered desktop NAS delivers reasonable performance and features at a good price

SCORE 

PRICE **Diskless/4GB, £638 exc VAT**
from [broadbandbuyer.com](https://www.broadbandbuyer.com)

Qnap offers a wide choice of entry-level SMB NAS appliances, and all bar one have a common feature: they're powered by Amazon. Or more precisely, chips by Annapurna, an Amazon company. Both the four-bay TS-432X and six-bay TS-632X continues this tradition, with a 4-core 2GHz Annapurna Alpine AL524 SoC inside.

The TS-632X is competitively priced, and that value is enhanced by the Alpine's integral network services, which offers dual 2.5GbE multi-gigabit and 10GbE SFP+ fibre ports. Memory starts at 4GB of non-ECC DDR4, and the single SO-DIMM slot supports up to 16GB.

No internal M.2 NVMe SSD slots are provided, but the appliance's spare PCI-E Gen3 expansion slot supports Qnap's QM2 dual-slot cards and plenty of network adapters. Just bear in mind they all need a flat mounting bracket.

The lack of an "H" in the model name indicates Qnap is aiming the TS-632X at SMBs that prefer its more nimble QTS operating system (OS). Qnap's QuTS hero isn't available as an option but this OS is too memory-hungry anyway as it needs at least 16GB of RAM to get the best out of it.

Behind the smoked plastic front cover you'll find six tool-free



hot-swap LFF/SFF carriers. For testing, we loaded up four Western Digital Red SA500 SATA SFF SSDs. The setup wizard neatly handled the installation of QTS 5.2 and, on completion, we used the Storage & Snapshots app to create a RAID5 array.

We opted to test over 10GbE and found performance to be a mixed bag, as the Alpine CPU doesn't handle write operations well. With a NAS share mapped over 10GbE to a Dell PowerEdge R760xs Xeon Scalable rack server, the Iometer benchmark returned speedy read rates of 9.2Gbits/sec, but write rates dropped to 4.8Gbits/sec.

It was the same story for IP SANs, with a 1TB target returning read rates of 9.1Gbits/sec and write speeds of 4.7Gbits/sec. Ramping up the pressure with a dual 10GbE MPIO link to the target saw read speeds hit 15.7Gbits/sec, but writes only increased slightly to 5.1Gbits/sec. We could also see from the QTS Resource Monitor app that CPU utilisation for the MPIO test peaked at 99%.

QTS offers a fine selection of business apps, although some aren't available for Arm-based CPUs. These include the Virtualization Station,

Hyper Data Protector and the Browser Station, and there's a much smaller selection of surveillance apps as well.

You have a good choice of backup tools, with QTS supporting on-demand and scheduled snapshots for NAS shares and iSCSI LUNs on standard EXT4 volumes.

ABOVE The TS-632X is good value for a six-bay NAS

The Hybrid Backup Sync (HBS) 3 app protects appliance data and helps create a 3-2-1 backup strategy in just four clicks.

HBS 3 uses Storage Spaces to define multiple local, remote or cloud destinations and, for the latter, HBS 3 supports Qnap's myQNAPcloud service, which is currently in beta. We had no problems using it: we signed up for a trial, received a free 16GB of cloud storage and created a new Storage Space for it.

"The TS-632X is competitively priced, and that value is enhanced by the Alpine SoC's integral network services"

Qnap's new NetBak PC Agent provides block-based backups for Windows workstations and servers but isn't supported by the TS-632X since it requires the

Hyper Data Protector app. All is not lost, however, as you can use Qnap's free NetBack Replicator app, which provides simple file-based client backups to the appliance.

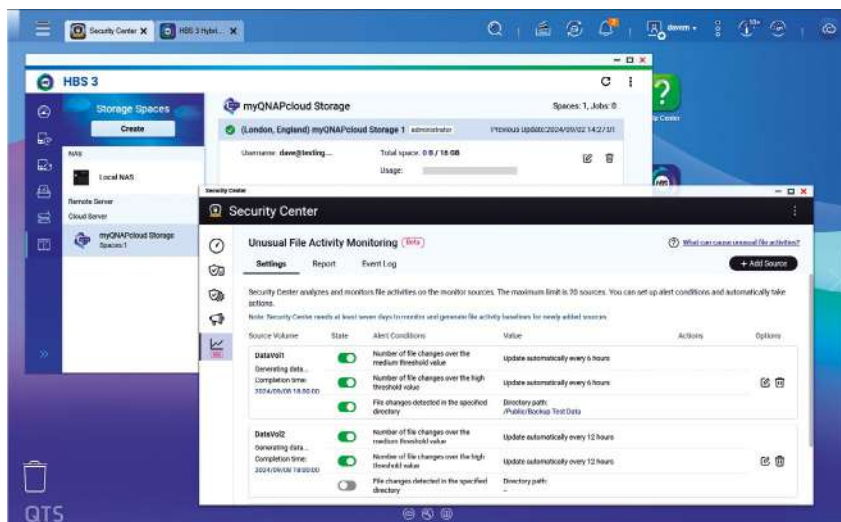
Data protection has seen a number of improvements, with the Security Center app now offering an unusual file activity monitor. It keeps a close eye on selected volumes and directories using a range of thresholds and if they are triggered, it can take a snapshot and set the volume to read-only to prevent any further changes.

A few QTS apps are missing, but the TS-632X offers a good hardware package at a comparatively low price. The Alpine CPU hampers 10GbE write speeds, but overall performance will be more than sufficient for the target market, and you'll be hard pushed to find a competing six-bay appliance for less.

DAVE MITCHELL

SPECIFICATIONS

Desktop chassis • 4-core 2GHz Alpine AL524 CPU • 4GB DDR4 SODIMM (max 16GB) • 6 x LFF/SFF hot-swap drive bays • 2 x 2.5GbE multi-gig • 2 x 10GbE SFP+ • PCI-E Gen3 slot • 2 x USB-A 3.2 Gen1 • external 120W PSU • 235 x 227 x 165mm (WDH) • 2yr hardware warranty



BELOW Qnap's QTS software offers a new unusual file activity monitor



Protect your business from AI-powered security threats

The rise of AI presents business-threatening cybersecurity challenges. **Davey Winder** explores the dangers – and how to defend against them

In the past, whenever artificial intelligence came up in the context of computer security, the discussion would tend to focus on the so-called Skynet scenario: the “machines are taking over” stuff from the *Terminator* films.

Now AI is an everyday reality, and Judgment Day hasn’t (so far) come to pass. What we are seeing, however, is a new wave of insidious and widespread AI-powered threats. Every business needs to be aware of how the new technologies make online exploits more dangerous than ever, and even open up new vectors of attack.

■ Phishing and phakes

One of the most powerful applications of AI is in the arena of phishing. Hitherto, that term has mostly referred to dodgy emails that appear

to come from a legitimate source, but once you add the ability to carry on wholly convincing human-like conversations, you’re into a whole new world of risk. In the past, phishing attempts largely relied on catching the recipient with their guard down, and getting them to immediately give up some item of valuable information. Now, all it takes is an API key for a mainstream LLM – which can easily be stolen – and criminals can use AI to convincingly carry on an interactive conversation for as long as it takes to get what they want from the target.

In one sense, this doesn’t necessarily change the game all that much. You’ve probably heard of sophisticated spear-phishing attacks, where criminals have directly impersonated senior staff to trick

victims into sharing something they shouldn’t, or masqueraded as bank officials to get them to confirm a fraudulent transaction. But such attacks have historically required a significant investment of manpower. AI changes that picture dramatically.

“AI can target individuals at scale, increasing the likelihood of success,” said Muhammad Yahya Patel, lead security engineer and evangelist in the office of the CTO at Check Point Software. “Attackers can create processes to exploit specific vulnerabilities and personalise

attacks far more efficiently than humans ever could.” In other words, AI can enable attackers to carry out sophisticated phishing attacks on hundreds or thousands of targets at once.

“AI can target individuals at scale, increasing the likelihood of success. Attackers can exploit specific vulnerabilities”

Even if phishing targets are cautious, avoiding scams is made a whole lot harder by the rise of another AI-powered technology: deepfakes. Adam Pilton, a senior cybersecurity consultant at CyberSmart, is in no doubt that deepfake attacks are the primary evolving threat to emerge from the success of AI technology. "At the start of the year," Pilton said, "we saw cybercriminals use a deepfake of a chief financial officer to trick an employee into transferring 25 million dollars to them."

This particular attack began with a relatively straightforward phishing email, which the employee was rightly sceptical of. "But when the employee joined a virtual meeting and saw and heard the CFO – as well as other people he recognised – all suspicions were gone."

That's the problem: while the security message about not trusting emails and messages has been driven home over the last few years, the standard advice is to take concerns to the person involved up the business hierarchy. But what if you can't be sure that the person you're talking to is real and not a deepfake?

"AI is becoming increasingly sophisticated," said Pilton, "the responses are increasingly accurate, and the number of tools and resources we have access to has dramatically increased, from simple text responses to pictures, audio, video and more." Deepfakes now have more realistic facial expressions, lip movements and voice synthesis, making them almost impossible to distinguish from reality at first, or even second, glance.

There's no easy defence against this. As Dr Andrew Bolster, senior research & development manager at the Synopsys Software Integrity Group, points out, identifying AI-powered bots "requires resourcing and secondary identity checks that can increase customer support and social media servicing costs".

Nor is this technique limited to the most dedicated and well-resourced attackers. Deepfake-as-a-service operations are becoming available on the dark web and criminal forums. Dr Martin J Kraemer, a security awareness advocate at KnowBe4, predicts that we can soon expect "deepfake video, audio and text capabilities to be added to existing phishing-as-a-service offerings, turning them into more comprehensive social-engineering-as-a-service toolkits".

■ Automated exploits

The risks of AI go far beyond social engineering. As Jamie Beckland, CPO at APiContext, told us, AI analysis can now be used to discover and exploit



ABOVE AI puts a whole new raft of tools at the disposal of cybercriminals

software and API vulnerabilities far faster than human hackers have historically managed. "This increases the likelihood of breaches occurring before patches can be applied," he said.

The danger isn't limited to code vulnerabilities in operating systems and apps. The same type of automated process can be directed towards any publicly available resource, such as cloud servers and storage services. It's easy to picture AI-driven exploit-

"AI analysis can now be used to discover and exploit software and API vulnerabilities far faster than human hackers"

discovery toolkits being turned loose on poorly configured or insecure setups, or being deployed to make the most of credential leaks.

Check Point Software's Patel agrees. "Attackers can gather and correlate this information quickly, spotting breaches, leaked email addresses or passwords used in past attacks and then use that data to craft more precise attacks against your organisation."

A related problem is API abuse, where malicious actors use AI to

analyse accessible APIs and exploit them where vulnerable, which can lead to data breaches at one end of the attack spectrum or large-scale service disruption at the other. "AI-driven bots can perform exhaustive testing of API endpoints to identify weaknesses such as inadequate rate limiting or insecure authentication mechanisms," Beckland told us.

And no matter how strictly your business is locked down against such attacks, you could still be the target of a supply-chain attack. This is where hackers compromise a weak link further down the supply chain, such as an external supplier, to get their malware into the desired target. Such attacks are a potential nightmare for IT managers, as even with the most careful security processes it's normally impossible to fully audit the code running on third-party devices coming into the business.

Again, warns Patel, this is an area where threat actors can leverage automated tools to find vulnerabilities. "AI can understand what is in your environment, who your partners are, and what other applications interact with your supply chain, giving attackers an edge in targeting their efforts for greater success."

■ Ransomware

An area of risk that you might not immediately associate with AI is ransomware – after all, you don't need AI to encrypt a disk full of files, right? But malicious encryption is only the final step of a multi-stage attack. As we've already noted, getting into sensitive systems and gaining access to valuable data are both areas where AI can empower the bad guys.

Etay Maor, chief security strategist and founding member of Cato CTRL at Cato Networks, warns: "AI increases

Social engineering

Adam Pilton used to be in law enforcement, working as a detective in charge of a cybercrime team, before joining the private sector and becoming a cybersecurity consultant. And in his view, the greatest threat from AI isn't conventional cyberattacks, but rather the invasion of our privacy.

That's because the sheer amount of data collected by technology interactions these days is vast. Picture what Facebook know about you, your activities, interests and associations. "What if an organisation holding such data was breached? Imagine collating all that information and asking an AI to profile a person," Pilton warned. What if cybercriminals used this information for AI-powered social engineering? "It no longer seems far-fetched to picture a cybercriminal receiving a notification that a victim has been effectively socially engineered, and is ready to be extorted."

the threat of ransomware by helping malicious actors to carry out attacks on enterprises.” Phishing is most often involved at the early stage in order to gain initial access, as is vulnerability hunting, and we’ve seen how these are being boosted by AI. Initial-access brokers, who sell compromised access to networks to ransomware affiliates, are certainly implementing tools to make their job more efficient.

There are other steps, too, such as “establishing a foothold in the network, assuring persistency, performing discovery, stealing passwords, escalating privileges, and setting up a staging platform”. Whether as part of the actual attack itself, or during the reconnaissance process, “threat actors are continuing to discover how AI can assist them in their crimes”.

The ransomware itself may soon be enhanced with AI, too. Currently, most perpetrators of ransomware attacks don’t create the malware themselves, but lease malicious encryption tools from a small number of “mastermind” developers. This means that while ransomware attacks may appear widespread and diverse, there are sometimes similarities in the way they spread and operate, which can help combat them, while the overheads of leasing limit the market of potential attackers. But AI could soon be used to create completely new types of malware that are harder to defeat and are available to anyone with access to a generative AI system. Right now, AI-generated malware is pretty crude and clunky – but, as Javvad Malik, lead security awareness advocate at KnowBe4, points out, “AI does lower the barrier to entry significantly, and will only get better”.

■ Protect against AI threats

Clearly, AI isn’t a single threat, but a powerful, versatile set of technologies with implications for almost every

aspect of cybersecurity. Rather than looking for a single solution, therefore, it’s necessary to think broadly about defensive measures. When dealing with deepfakes, for example, Jamie Beckland recommends that businesses consider robust multi-factor authentication systems that verify not only user credentials but also behavioural biometrics. “Advanced monitoring tools detect anomalies in communication patterns and transactional behaviours that can help identify and prevent unauthorised activities before they escalate,” he said.

And let’s not forget that the very technology that’s being deployed against us can also be used to our advantage; AI isn’t a one-way street when it comes to cybersecurity. Phishing attacks, impersonation and social engineering are all areas where AI can be deployed to exploit vulnerabilities, but, as Muhammad Yahya Patel says, “the automation enabled by AI can also help in vulnerability management, continuously scanning for weaknesses within an organisation’s supply chain or cloud environment”.

The same applies in areas such as API abuse. As Beckland advises – unsurprisingly, given the line of business he’s in – you shouldn’t ignore “the importance of continuous API monitoring and automated vulnerability scanning, to minimise the window of opportunity for malicious exploitation”.

To be clear, though, that doesn’t mean looking for a silver-bullet AI-based security solution. Silver bullets don’t exist when it comes to AI threats, any more than they do for



ABOVE The best protection is via employee training and awareness

anything else. Old-school security measures such as 2FA, account separation, patch management and network segmentation remain of the utmost importance.

“Organisations considering the deployment of AI-based solutions should avoid rushing in just because it’s the latest trend,” said Etay Maor. You need to thoroughly appraise and trial systems before rolling them out. Fortunately, there are several frameworks available to assist with

“AI could soon be used to create completely new types of malware that are harder to defeat and are available to anyone”

this, such as Google SAIF, NIST AI RMF, the OWASP Top 10 for LLMs, and MITRE ATLAS. “These frameworks help organisations understand the risks, attack surfaces, and potential threats to AI-based systems,” added Maor.

And the best defence against the malicious use of new technology, in the opinion of Adam Pilton, isn’t technical at all, but rather takes the form of employee training and awareness. “It’s imperative that we regularly educate employees about AI-driven threats,” Pilton said. “We must make it clear that employees should be cautious about the information they share on public platforms, as AI can easily scrape social media to craft targeted social engineering attacks.”

A powerful way to achieve this is to make it real. “By conducting periodic tabletop exercises and attack simulations,” Pilton concluded, “we test the effectiveness of our incident response plans, crucially including our response to AI-related attacks like deepfakes or automated exploits.”

Dr Martin J Kraemer agrees that awareness training has to go beyond the written word or periodic chats about threats; it needs to include exposure to the threat itself. “Record a deepfake video of the CEO,” he recommends, “and use that as awareness material to demonstrate the threats to everyone.” ●

In-house AI dangers

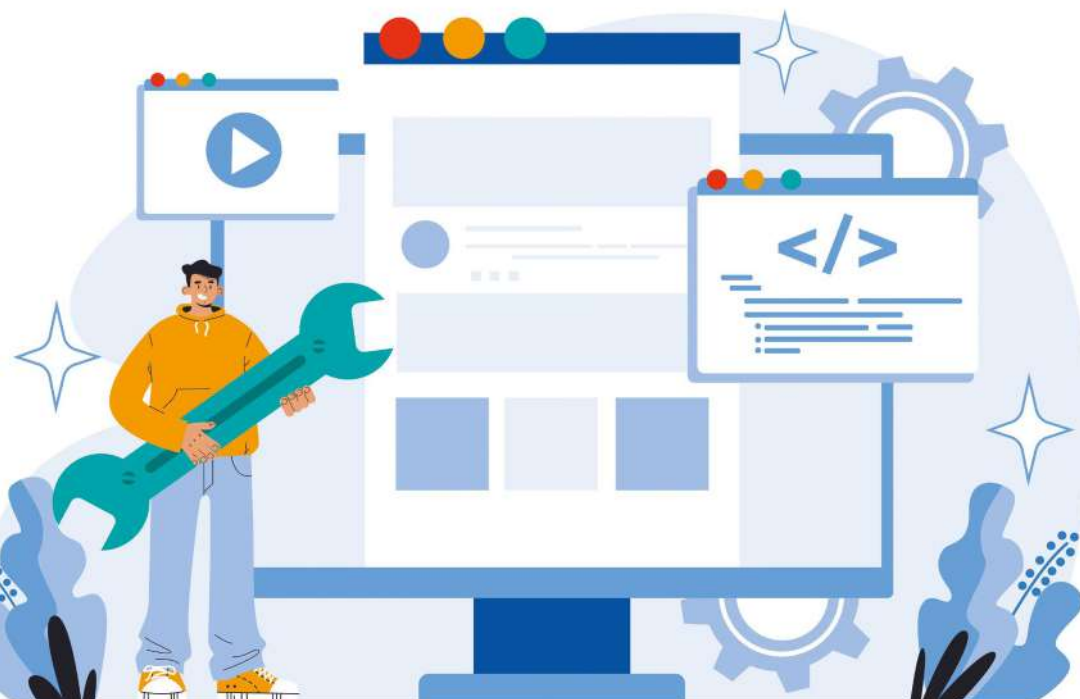
While many businesses are rightly concerned about attackers using AI for nefarious purposes, IT managers also need to be aware of the potential risks of using seemingly innocent AI tools themselves.

For a start, it’s well known that AI can “hallucinate” facts and figures, and even if you’re only relying on an AI to summarise or analyse supplied information, there’s always a risk that it will miss or mis-state important points. If you rely on the output of an AI, you could end up making the wrong decisions, with potentially disastrous results.

AI tools are also vulnerable to “prompt injection attacks”, where a malicious actor gives instructions to the AI to make it do something it’s not supposed to do – such as revealing confidential data that it’s

previously processed, or giving bad information when quizzed. The UK government’s National Cyber Security Centre offers some online advice for working safely with AI (see tinyurl.com/363ncsc), and an extensive government-commissioned study was published in May exploring vulnerabilities in AI systems (tinyurl.com/363study).

We’d strongly recommend that IT managers read the entire report, but if you need to know just one thing, heed the NCSC’s advice that “keeping AI systems secure is as much about organisational culture, process and communication as it is about technical measures”. In other words, assume the worst of any AI system, and take steps to ensure that your workflows aren’t leaving you vulnerable to unintended mistakes or intentional exploits.



What is a CMS?

If you're running any sort of website, a CMS is a must-have. Steve Cassidy explores how it helps you, and everyone else

Another initialism – lucky us. So is this a product, a service or what?

We're talking here about the broad category of "content management systems" – online platforms that serve as both a central repository for content and an overarching organisational tool for managing how and when each item appears on your website. The most popular CMS is WordPress, but there are many other options, both free and commercial.

Is this really necessary? Can't we just upload pages as needed?

It's fair to say that some of what a CMS does simply automates processes that are perfectly doable by a human. But there's nothing wrong with that: it saves time and reduces the risk of mistakes. And as websites have got ever bigger and more complex, it's become unrealistic to expect a human to reliably manage one.

Doesn't introducing a CMS into the mix further complicate things?

It certainly can. I know information workers who have burnt far too much midnight oil grappling with the workflows of various upload managers. But the value of a CMS is easier to appreciate when you

remember that, nowadays, the website you're updating is almost never solely your own concern, but represents a surprising number of interested parties.

Hold on – who else has a stake in our company website?

Even back in the days of DIY sites, businesses had to deal with connectivity providers, hosting facility operators, local end-user software vendors, security scanner developers, browser developers and more. For a field with such

minimal actual computing demands, website presentation has spawned a remarkable menagerie of roles, each with their own strong opinions about how things ought to be done.

And a CMS brings together all their different requirements?

Well, hopefully it can be made to do so. While each CMS platform will have its particular strengths, all of them are designed to be highly configurable and even somewhat chameleonic, so different types of user can experience them in the way that best suits their needs. For instance, content creators typically treat a CMS as a database for all their output, while for site managers it serves more as a workflow and publishing planner. The security and legal teams tend to be more interested in the logs and histories of what's been said and shared in the past, especially if your site turns over its text or design frequently.

So how do we go about choosing and deploying a CMS?

If you're already running your business in the cloud, it's a good bet that your hosting provider will natively support at least one of the big open-source CMS platforms (if not several of them). Whichever one that is, it will almost certainly include all the core features you need – and if it doesn't, they can be added with extensions. So it usually makes sense to use whatever platform is put in front of you, and let the provider take care of deployment and maintenance.

Retail businesses, however, may prefer a commercial CMS such as Shopify, Squarespace or Wix, which come with integrated e-commerce services as well as general site hosting and management capabilities. For the maximum in-house control, there's nothing stopping you from installing your chosen CMS platform on a cloud server and running it yourself – but there's rarely much to be gained by taking this route compared to using a bundled option. ●

The word on WordPress

If you're wondering which CMS a particular site is built on, it's probably WordPress. Originally released in 2003, the open-source CMS is by far the world's most popular online publishing platform, with an estimated market share of around 65%.

That very popularity makes WordPress an attractive choice. It's included in most hosting packages, and it's easy to find documentation and expertise online, along with a vast range of plugins to power anything from news sites and blogs to shopping sites, image galleries and technical databases. Believe it or not, it's estimated that more than 40% of all websites run on WordPress.

Lately, though, WordPress has also been the subject of controversy. In September, WordPress co-founder Matt Mullenweg hit out at a third-party host called WP Engine, accusing it of profiting off the WordPress brand and not respecting its open-source licence. Mullenweg's aggressive stance has led to more than a hundred staff quitting WordPress in protest, while WP Engine has filed a lawsuit accusing WordPress of extortion.

Whatever the fallout, there's no real risk to the WordPress platform – that's the beauty of open source – but if you prefer a quiet life, drupal.org or joomla.org are strong alternatives with less drama.

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Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

“The more I have to do with UK telcos, the more broken their systems seem to be”

After being tempted by the iPhone 16 Pro Max – for professional reasons, honest – and the Watch 2 Ultra, Jon discovers not everything is perfect in Apple’s new generation

It has been a month of bits and pieces. Nothing dramatic, but a whole host of small changes, some of which are still outstanding.

Let’s start with the annual ritual, which is the arrival of the new iPhone and Apple Watch.

I keep myself to a fairly rigorous tick-tock regime for these upgrades. I went from iPhone 13 Pro to 15 Pro Max, missing out on the 14 release. I was going to skip the 16 Pro Max as well, but two factors coincided: first, a bunch of technical improvements that were all relevant to work; the second more personal.

I’ll cover the three technical reasons first. The iPhone 16 Pro is Apple’s first device to support Wi-Fi 7 (802.11be). So far, I haven’t been impressed by anyone’s 802.11be Wi-Fi 7 implementations, either on the client or access point side, as I can’t get it to go faster than a well-implemented Wi-Fi 6E 802.11ax setup. In testing, throughput of user data tops out at around 1.8Gbits/sec, which is far from shabby, but that’s on a test environment which is 10GbE throughout (the local test servers can feed a full 9.4Gbits/sec speed). So seeing how Apple is going to implement 802.11be is both of technical interest and helpful when I’m testing Wi-Fi 7 devices.

The new 48MP wide camera is also interesting because it aligns better with the 48MP main camera. The 15 Max Pro “only” has a 12MP wide camera. And why the interest? I want to see what improvements this makes to 3D depth camera footage for the Apple Vision Pro. Finally,

Apple promises faster MagSafe charging and longer battery life, by changing to a later TSMC process.

I have one more personal reason. I’m a huge believer in passing equipment down the internal food chain, and my partner Andre’s iPhone 11 Pro is dying: the speakers are very quiet and the battery life poor, reflecting a long hard life. So I decided to replace my existing 15 Pro Max 1TB with a new 16 Pro Max 1TB, and Andre will get the 15. The 11 Pro will enter the pool of desk devices used in the lab when software needs to be evaluated, and it will live out its life until it is no longer supported by the current operating system.

Next up is the new series of Apple Watches. I lost interest in the standard version of the watch when the Ultra came out, because of the significantly increased battery life on the Ultra compared to a normal Watch. The battery level drops by approximately 25% between 6am and 9pm each day, so it’s easily capable



Jon is the MD of an IT consultancy that specialises in testing and deploying kit
[X @jonhoneyball](#)

BELOW No new Apple Watch for me this year, except... ooh, it’s titanium black!

of being used for several days, especially if you switch it off at night.

I’ve been very pleased with the first-gen Ultra that I bought on release two years, and had no intention of upgrading to the Ultra 2. I had hoped for an Ultra 3, as many pundits predicted, but it hasn’t come to pass. I suspect Apple is holding its ground, waiting for more sensor technology to be included. Hopefully blood sugar measurement, which Apple has apparently been working on for years. It can be done, but making it stable and reliable is difficult compared to continuous glucose monitoring devices such as the Dexcom and Libre. And even they need calibration against blood finger prick testing. I’d like to stop using Dexcom, if only because of the £150 a month I have to pay for it.

So no Ultra 2 for me then. Except... it’s now available in black. Titanium black, no less. And Apple announced that it’s going to offer a sleep apnoea measurement capability on the Ultra

2, too. As someone who suffered badly from sleep apnoea in the past, and uses ResMed CPAP/APAP machines each night, I am intrigued as to how good the measurement of Ultra 2 will be. Especially since those Apple Watches sold in USA can’t use the blood oxygen measurement feature, due to an ongoing patent dispute.

Even with through-the-skin blood oxygen measurement, and





Jon Honeyball

Opinion on Windows, Apple and everything in between – p108



Lee Grant

Tales from the front line of computer repair – p111



Olivia Whitcroft

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Davey Winder

Keeping small businesses safe since 1997 – p118



Steve Cassidy

The wider vision on cloud and infrastructure – p122

using the microphone to detect snoring, I'm still not clear how well this will work. My comparison point is the data collection on a modern CPAP/APAP machine, which stores breath-by-breath measurements to an SD card. Download the wonderful OSCAR software (sleepfiles.com/OSCAR) and you get incredible insight into what's happening as you sleep. Comparing the two is going to be fascinating. So, in the interest of research, I now have an Ultra 2. In black, of course.

Moving from the Ultra 1 to the Ultra 2 Watch should have been simple. Apple has a migration tool that kicks in when you register a second Watch to your phone, and it offers to move everything across. Of course, you can set it up as a new device and keep both connected to your phone, but most people will be migrating from one to another and then removing the first.

As you would expect, this "just works". Except for migration of the eSIM. On my phone, I have a primary physical SIM from Three and an eSIM from EE. This is largely historical: I wanted to have eSIM within my watch to try out the capabilities if the watch is away from the phone. When out on a long cycle ride, for example.

At the time, only EE had an eSIM that worked on the Apple Watch, and it has moved forward with me over the years. Today, you can get Watch-compatible eSIMs from various vendors, but trying to locate them on their websites is an exercise in utter futility. They offer data-only eSIMs, but you want the full phone capabilities on the eSIM because the Watch works as a full telephone with voice.

Far from seamless

Anyway, back to my migration. The tool includes the ability to move the eSIM across. Basically, it has to be unregistered from the existing watch, and then registered to the new watch, and this has to be done with the telco supplier. It should work seamlessly. You choose the eSIM on the phone to attach to the watch, and tell it to apply the eSIM to the new watch.

With EE, this didn't happen. I received a message appearing on the phone screen from EE telling me

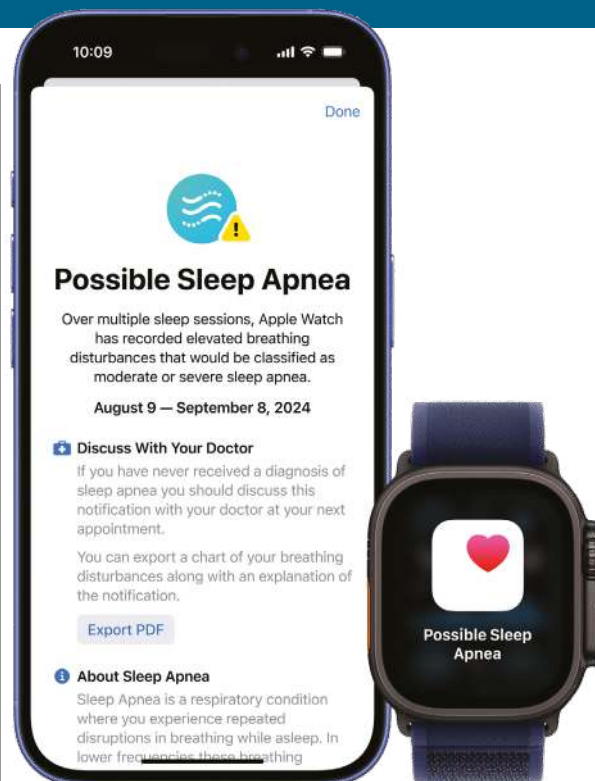
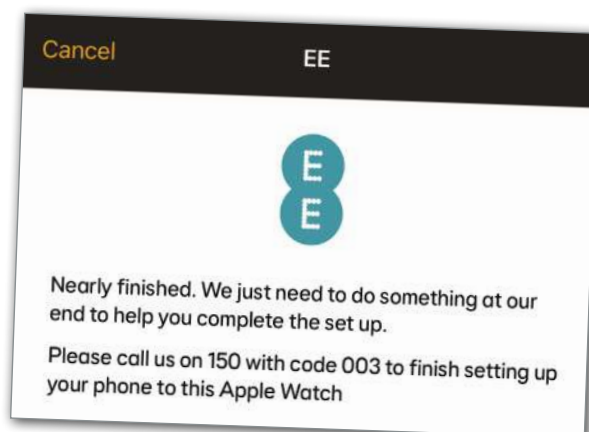
that the process was nearly finished. "We just need to do something at our end to help you complete the setup. Please call us on 150 with code 003 to finish setting up your phone to this Apple Watch."

So I called 150 from the EE line on the phone, and of course there is nowhere to enter "003". I then started wandering around their support line, trying to get to technical support for phones. After all, the Apple Watch is a full phone. Then I landed in a queue telling me it would be about 30-45 minutes. I hung up and hoped that the "something at our end" would resolve itself overnight.

The following day, I found exactly the same error on attempting to load the eSIM onto the watch. So I called 150, and quite quickly got through to a helpful support assistant. It turns out that the EE backend cannot cope with a change of EID from one watch to another. Clearly it hasn't coded this to support the change presented from the Apple migration tool. So I had to read out the super-long EID of the new watch to the support lady, and she typed it into the system. After about ten minutes, the eSIM went live on the watch.

This is absurd, and she confirmed that every single watch migration required manual inputting of the new watch EID into EE's system.

Even worse, the dialog presented to the user is giving incomplete and frankly wrong information. It should say, "Phone us so we can take the EID number of the new phone". And the phrase "call us on 150 with code 003" means nothing. Something like, "Call us on 150, press the following numbers to get to iWatch eSIM migration" would be far more useful.



ABOVE The Ultra 2 is offering the ability to measure sleep apnoea

"Frankly, it boggles my mind that eSIM support is so utterly pants"

BELOW Moving an EE eSIM from one watch to another isn't easy

Frankly, though, it boggles my mind that eSIM support is so utterly pants from all the major suppliers, both on phones and smart devices. A few weeks ago, when Tim and I were in Berlin for the IFA 2024 show, I went back to the Holafly service that I've used before. I purchased an eSIM with unlimited 5G data for the days I needed. Setting it up on the phone was incredibly simple, with the phone reading a QR code from the resultant email.

Why is it so hard with UK telcos? The more I have to do anything with them, the more horrible and broken their systems seem to be. The sooner that Apple sets itself up as a global mobile virtual network operator (MVNO), the better it will be; I would move in a heartbeat. Imagine getting an eSIM on demand for whatever days I needed, irrespective of where I was in the world. Or having a setup that had a workflow that automatically gives me 5G data plus a phone number when I land in the US, bills me for the days I was there, and then automatically shuts itself down when I leave.

Vision Pro on business trip

This week I had to be away from home for a few nights on a business trip. I know that most hotel rooms have a



TV nailed to the wall, but I can't remember the last time I used one. The picture quality is patchy, and it's usually too far away to be easy to watch. Indeed, I wonder why hotels fit these things. Of course, some higher-end hotels offer information about your stay – you can sometimes see the status of your bill, check out when you're leaving and look up flight data. All of which has value, but is a pale solution compared to a properly secured website.

After dinner, and once all work emails have been done, I would prefer to watch a film on my laptop. Or on my iPhone, at a pinch. But this time I took the Vision Pro with me. It was amazing to sit in bed and watch James Bond on a 20-foot-wide screen in superb quality. I have a travel case for the AVP, and will be taking it more frequently. Only the size is a limitation for carry-on for a plane, although when I see what people drag onto a plane in the name of carry-on I'm tempted to use AVP rather than the in-flight entertainment even on long-haul flights. Connect it up to a large USB-C battery charger pack and the flight will pass much more smoothly. Most in-flight entertainment systems on planes are poor quality, and often unreliable. Even the new system on British Airways' club class service has required multiple reboots on recent flights.

Best to take what I want to see, on the screen I want to use. Although to be realistic, an iPad Pro is significantly easier to carry.

Where's 5GHz Bluetooth audio?

There's one that I'm annoyed about on the new iPhone 16 Pro models. I accept it's a niche nerdy point, but it bothers me considerably.

To get the AirPods Pro working at ultra-low latency (sub 20ms) for the Vision Pro, it was necessary to re-engineer the Bluetooth stack to work on 5GHz rather than the normal 2.4GHz implementation. Using a much faster Bluetooth connection allowed for 192kHz, 24-bit (or 20, it's unclear) high-definition audio.

This was introduced on the USB-C version of the AirPods Pro, so I was looking forward to the iPhone 16 Pro supporting this new Bluetooth mode for higher-quality headphone capabilities. But there's no mention of it. To say I'm disappointed is an understatement. Apple has the tech and didn't implement it. And there is no sign of it on the updated AirPods Max headphones, now shipping with USB-C.

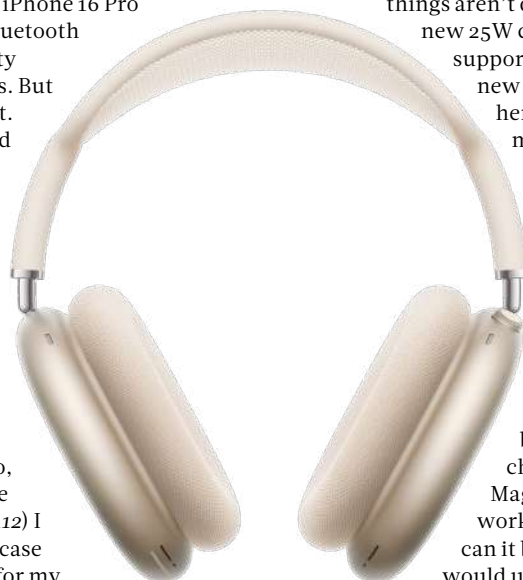
Wireless charging woes

A couple of months ago, as I mentioned on these pages (see issue 361, p112) I bought the Quad Lock case and mounting system for my

ABOVE The Vision Pro beats the in-flight entertainment on a plane hands down

"It was amazing to sit in bed and watch James Bond on a 20-foot-wide screen"

BELOW The updated AirPods Max are lacking 5GHz Bluetooth



iPhone 15 Pro Max. I was expecting to use the phone for satnav operation on my motorbikes. Quad Lock's cases are of high quality, and it offers a wide range of charging and vibration reducing mounts, which are important on a motorbike.

I put its charging car mount into my Audi, and this works well. Well, up to a point. You'll recall me finding that its claims for MagSafe-charging compatibility were actually not true at all, despite it being on the product boxes.

So why the disappointment? Well, it comes down to the charging rate. Quad Lock's chargers can only manage 7.5W, and this is shown in the iPhone's Battery app as orange charging status. When using the phone in the car using CarPlay wirelessly, and also satnav such as Waze, the charging rate of 7.5W barely keeps pace with the discharge load, and so I've been on trips where the phone only managed to maintain charge level during the drive. This is disappointing, because MagSafe will run at 15W. On the iPhone 16 Pro, it will run at a much more impressive 25W. And so, in moving to the 16 Pro Max, I can either stick to the 7.5W charging rate in the car, or go with 25W on a MagSafe mount, if I can find a higher-rate MagSafe mount for the car.

I accept this sounds like the very definition of a first-world problem, but the Quad Lock Mag mounts get very hot indeed when delivering its measly 7.5W. And my motorbike needs have been supplanted by the CarPlay head unit I talked about last month. So maybe it's time to move back to the MagSafe mainstream.

I say "maybe", because it appears things aren't quite that simple. The new 25W charging rate is supported by Apple's own new MagSafe mounting, but here I'm talking about mounting on the end of a cable. Trying to find the charging power on third-party charging mounts for cars is an almost futile process; most don't even tell you what the charging rate will be. I shall keep my eyes on this, because I want 25W charging in the car, on a MagSafe mounting that works properly. How hard can it be? If only Quad Lock would up its game, I'd have the

best solution. But a 7.5W charging rate doesn't cut it for me any more.

Security camera options

Before I bring you up to date with the latest happenings in the security camera space, here's a little reminder from Uncle Jon: security cameras for your home or office have specific design requirements. They should be mounted high on the building. They should be connected by Ethernet, and powered using PoE (power over Ethernet). They should be recording 24/7 to a centralised server within the building. All of these items are non-negotiable for a security camera system. I have no objection to cloud-based, Wi-Fi-connected cameras, but they're not suitable for the security task.



ABOVE Synology's BC500 security cameras are brilliant, but hard to get hold of

I like the Synology platform, and Ubiquiti's UniFi platform, too. The recent Synology BC500 cameras are excellent, and I need to buy two more. But they're out of stock everywhere, and appear to have been so for some time. I could buy the similarly impressive UniFi cameras, but that would be a migration to the UniFi Protect platform away from Synology.

UniFi, however, is opening up its platform to third-party cameras that use the ONVIF open platform for security cameras. It seems that competition does improve the options for us users.

To be honest, I would be happy with either solution. Synology works well in a very mixed environment of network technologies. UniFi's Protect platform is best within a UniFi solution. Since I have both, I can evaluate them against each other, and migrate my existing cameras to the UniFi platform if needed. Either way, I win.

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LEE GRANT

"I make no apologies for my pedantry; Microsoft should know the names of its own products"

Lee reveals the repair headaches of foldable laptop screens and presents a tale so terrible it comes with its own sound effect

One of the many joys of writing for this fine publication is getting to talk about computer problems that trip up real PC users. If you think about it, every edition of *PC Pro* follows a technology timeline. At the front is the latest news, where we learn about bleeding-edge developments that will eventually filter down to this part of the magazine, *Real World Computing*, where we reflect on how these developments affect our lives, before Nicole's Futures section tells us what's going to happen tomorrow (but not in a "here's the winner from the 2.15 at Wincanton tomorrow" way).

As stories pass through these stages, it allows us to revisit them as they contort and grow from a simple startup idea into a dominating global brand that improves humanity in ways that were inconceivable several years before. This month, sadly, it just gives me another chance to bellyache about how the brains running Outlook are determined to frustrate my customers.

Cast your minds back to the start of the year (see issue 355, p113) where "Outlook (new)" had begun to sneak onto PCs and was causing stress in certain quarters. In the intervening months, the utter confusion caused by dropping an app onto a PC that has almost the same name as the email client contained in Office 365 has been the cause of many calls to our shop. The impetus for revisiting Outlook



Lee Grant and his wife have run a repair shop in West Yorkshire for over 20 years
X @userfriendlypc

"The brains running Outlook are determined to frustrate my customers"

BELOW Meet the new Outlook for Windows

again is because, as autumn began, Microsoft implemented more name changes for the Outlook twins.

The first change is that Outlook (new) is now "Outlook for Windows", which makes a lot more sense. Its description within the Windows Store reads, "This app will replace the Windows Email, Calendar and People apps", which is also understandable, but incorrect. Windows Email doesn't exist. The app being replaced is called Mail, and I make no apologies for my pedantry as Microsoft should really know the names of its own products. Perhaps the existence of a Microsoft mail client that isn't called Outlook has confounded the store's AI bot.

The second change seems to be more subtle and, at the moment, not as widespread. Outlook, by which I mean the client that comes with Office 365, has taken some inspiration from Adobe's nomenclature and is now "Outlook (Classic)", and that it is. A more suitable name could be Outlook (Vampire) because, despite Microsoft's neglect in the way of feature updates, the software remains staggeringly hard to kill off.

Microsoft launched Outlook in 1997 and it wouldn't surprise me if there are still installations of that phasing a mail server somewhere. Outlook is from a generation of software that modern publishers now hate because its users won't abandon it. I still see many versions of Office 2007 and 2010 giving adequate service

and, to give Microsoft credit, they still activate without a glitch. So what tempting treats is Microsoft laying down to entice apathetic users away from Outlook (Vampire) towards Outlook for Windows?

The most succulent tempter is that Outlook for Windows is good software. It has a fresh new look and features that modern mail apps





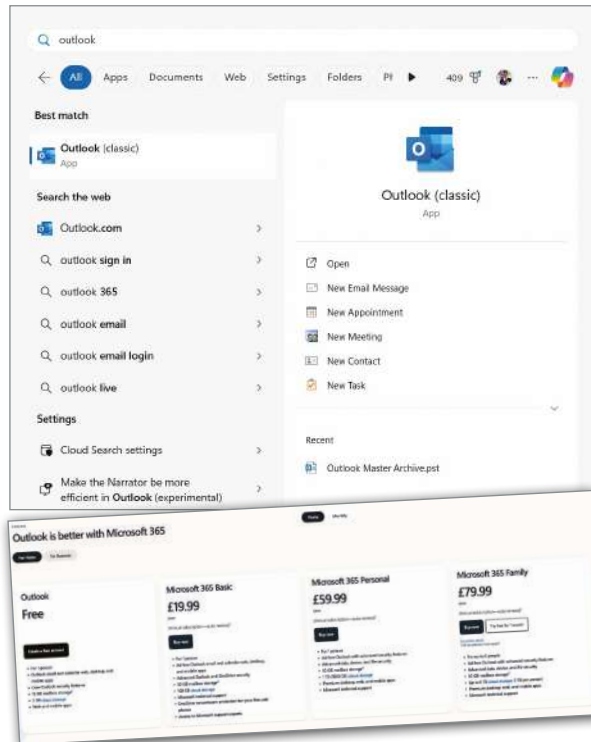
should have, such as spam sweeping. Although Outlook for Windows isn't perceived as Outlook (Vampire)'s natural successor, it appears it will be. A Microsoft blog published in March (tinyurl.com/363outlook) stated: "New deployments of Outlook from Microsoft 365 subscriptions will feature new Outlook for Windows." The exact timeline on this switchover isn't clear, but I suppose that software with the suffix of Classic is destined to age into Legacy.

However, my customers don't like the adverts that appear in Outlook for Windows. Although there aren't too many currently, they're wary of more appearing. Microsoft's solution to this is a cheeky £20 per year subscription to Microsoft 365 Basic, which will banish adverts and increase mailbox capacity, but I can assure you that persuading users to move from perpetual licences to subscriber licences is challenging. Office 365 subscribers don't currently see adverts, but we live in a bait-and-switch tech landscape, and paying for products no longer guarantees they'll remain advert-free forever.

As the heir apparent, Outlook for Windows' development continues. I mentioned the software's lack of PST support back in issue 355, but Microsoft says it will add this during March 2025, removing a barrier to many Outlook (Vampire) users. When I asked Microsoft if it planned to discontinue Outlook (Classic), it told me: "Microsoft will continue to honour published support timelines for existing version of classic Outlook for Windows until at least 2029." Classic Outlook for Windows? Where did that come from?

Foldables: A race to the bottom?

Last month I glimpsed the future. What arrived in our shop was a Lenovo laptop with a foldable screen, but before you go frantically scrabbling through back issues looking for Tim's exclusive review, I must warn you that you won't find it. This machine wasn't an advanced prototype, just a standard laptop that's been sat on. It had a foldable screen because all screens are foldable, but some only once.



The machine was sent back to the owner a few days later. Thankfully, the aluminium alloy lid of the Lenovo was straightforward to reshape. I won't claim that it was showroom quality as I'm not a trained panel beater, but the edges and corners were straight, with the buttock-shaped imprint barely noticeable.

My reason for mentioning this machine is to highlight a supply problem with laptop screens. The smashed panel inside this machine was nothing exciting, a 15.6in IPS 1,920 x 1,080 affair. I keep a supply of these on the shelf as they're a common part across various mid-range and budget laptops. Take a gander at the specifications of an average laptop and you'll see figures similar to the ones I've mentioned, but rarely will a specific brand of screen be listed. The reason for this is that many laptop makers will shove in anything that hits the spec and price. If you've ever unboxed multiple laptops purporting to be identical models, you'll know that slight visual differences between displays are common.

TOP Outlook (Classic) is hard to kill off, despite Microsoft's best attempts

ABOVE You'll have to pay to get rid of the ads

"It had a foldable screen because all screens are foldable, but some only once"

BELOW The specs were the same, but the screen didn't fit



The factor that prevented any of my stock going into the bendy Lenovo was physical. You may imagine that a 15.6in panel would be a standard size, and you'd be right as far as the viewport is concerned, but underneath that, hidden from view, is a circuit board holding the electronics that perform the magic. The dimensions of the PCB vary, and on this foldable Lenovo it was far shorter than anything I had in stock. The PCB sits snugly between the hinges at the lowest part of the screen module, and the PCB models I had were too wide. Fortunately for this user, I sourced a replacement quickly, but for another customer with a quirky screen PCB, it took myself and my suppliers much longer.

Innolux or Outtalex?

This customer's machine was an Asus Zenbook UX425J, a slim 14in machine with an unimportant specification. This user had broken the screen in the classic way, shutting the lid with a pen on the keyboard. The cracked screen I extricated from the Zenbook was made by Innolux, which is exactly what I ordered from my supplier. What arrived was a screen made by BOE but, as it hit the right specs, I was unconcerned.

It fitted perfectly into the housing, but I struggled to hook in the LCD cable that connects the panel to the motherboard. The simple reason was that the LCD connection socket on the rear of the BOE was 10mm adrift from the Innolux's placement, so the LCD cable wouldn't reach. 10mm doesn't sound a lot, but laptops are built to a budget-controlled spec that ensures cables are the ideal length and there's no allowance for any other scenario.

This customer was in a hurry so I stripped the laptop to lengthen the cable but could only squeeze another 2mm out without over-tensioning the wire. As the clock was ticking, I ordered another Innolux screen from a different supplier, but another BOE screen arrived the next day. Over three days I ordered eight Innolux screens from various suppliers and received eight BOEs.

You'll find that most screen suppliers will have a disclaimer along the lines of "We may supply a 100% compatible part for your screen number," which is acceptable if the compatible part

works. For this Zenbook, they may have well shipped me a horse.

In desperation I spoke to my principal supplier, who explained that somewhere in the supply chain, the Innolux and BOE have been listed as compatible, when they aren't. There is the simple explanation as to why every supplier had made the same error.

The real issue here is why Asus used this Innolux screen, which has such a bizarre connection placement. Is it proprietary hardware by another method? One of the genuine concerns about Right to Repair is that cash-addicted manufacturers will exploit the idea. As they'll be required to sell parts, they'll make things breakable so they can clean up on spares, and the way to maximise this revenue stream is to pimp parts so that we're forced to buy their version. Of course, this is nothing new.

Readers with long memories may recall a leading PC manufacturer that used to supply computer packages with a printer made by a leading printer manufacturer. Now, I've changed the names to protect the innocent, but the printer branded with the Lell label was the same model that you could buy in Dixons, and Comet made Dexmark. What annoyed Lell's customers is that the Dexmark cartridges were around half the price, but couldn't be used in the Lell printer as they'd been modified to not fit.

Sadly, history doesn't recall the name of the computer shop technician from Yorkshire who took a rasp file to a Dexmark cartridge so it would work in a Lell printer in order for a frantic boy from the village to hand in his coursework.

Care for something from the keys board?

Which brings me to an HP laptop that arrived during the summer. The owner had pinged off the "H" key and bought a replacement from an online vendor. When this didn't fit, he bought a different one, which condemned Sisyphus to repeat the cycle until by Mrs Sisyphus ordered him to bring it to me. He'd bought three "H" replacements and a "T" (I didn't ask), but while digging back through his purchasing history, I learned that this one HP model has three versions of the same keyboard. Why? The differences are nothing to



do with layout or language, just the articulation movement of the keys that all use the same keycap and look indistinguishable to the user.

Ten minutes with a microscope and tweezers resolved the issue but left me further perplexed by the tech industry. One minute it won't give cable slack for a very specific screen and the next it's re-invented the wheel three times for no reason.

Free sound effect with every issue!

Before we continue this vague thread of technological idiocy, you're going to need this sound effect (tinyurl.com/363dundunduun). I'll give you the nod when to hit the play button.

A desktop arrived with an extremely full SSD. The confused owner shrugged, as they really don't do too much with this machine. They wanted to update their TomTom but it refused, proclaiming: "No disk space available on your computer for caching. Please free up disk space to resume."

Time to click around for a quick fix. First, I look at the folder properties of the Pictures, Documents and OneDrive folders to get an idea of sizes; staying at folder level minimises

ABOVE Keys to the problem: they may look the same, but the keys are different

"If you walk into a room and you can't spot the cache-hog, then you're the cache-hog"

BELOW TomTom: hogging all the space



my footprints over the user's data, which is very important. Despite what some anti-repair advocates profess, I really have no interest in which recipes someone has downloaded from BBC Food. Everything looked fine, but the 480GB SSD was bulging.

I used SpaceSniffer (tinyurl.com/363spacesniffer) to find the blockage and it spotted an overflowing HOME3 folder tucked away within App Data containing over 230GB of data. What controls the HOME3 folder? It was...<<PRESS PLAY NOW!>>... TomTom. The swine! Well, you know what they say, if you walk into a room and you can't spot the cache-hog, then you're the cache-hog.

The fix was easy as TomTom has a "Empty download folder" hidden in the settings, but it would have saved the customer a lot of trouble if TT's developers had offered it as an option for the error message.

A grovelling apology

Finally, a correction kindly brought to my attention by Dave, a *PC Pro* reader from south Buckinghamshire regarding Local Microsoft accounts, which I covered two months ago (see issue 361, p115). He says: "Good morning, Lee, I absolutely love your column in *PC Pro*, it's the first thing I turn to." It should be obvious to all magazine editors who read this that Dave is clearly a man of taste, truth and integrity. He continues: "You need to put a backslash between oobe\bypassnro – rather than a forward slash – oobe/bypassnro – to get the command to work."

Thanks, Dave, for your keen eyes, and I apologise to all that have struggled because I got my slashes muddled. As the ancient proverb states: "Man who slashes backwards can reset PC. Man who slashes forwards has wet shoes."

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OLIVIA WHITCROFT

“It was the dawn of e-commerce, and we were trying to apply offline law to the new online world”

Olivia rolls back the years to when the internet was reshaping laws and – would you believe it? – data protection wasn’t considered a sexy subject

Following the recent Argos TV debacle, companies venturing into the new world of e-commerce should review their process for contracting over the web. Argos advertised its televisions on its website for £2.99 instead of £299, and was deluged with orders, which it is now reluctant to fulfil. Was there a valid sales contract or not? Stay tuned for the new Electronic Commerce Directive from the European Union. This will clarify the moment at which an electronic contract is concluded, which could impact the outcome of similar cases in future.

With Y2K just around the corner, it is also vital to check that your IT outsourcing contracts address business continuity issues as we move into the year 2000. While you’re about it, you should build in additional provisions relating to the use of personal data. New data protection requirements for arrangements between organisations and their IT providers (processors) will apply from March 2000.

And with the evolution of interesting “peer-to-peer” software, rights holders need to have a hard think about how to protect their creative works. Napster claims not to be copying or authorising the copying of any music; all it does is provide the software. So should rights holders be trying to stop these communications, or perhaps embracing new ways to exploit their works?

What are you on about, Olivia?

Sorry about that. I was reminiscing about the excitement at the end of 1999, when I started my legal career. Having daydreamed through PC Pro’s 30th anniversary edition, I’m late to



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“IT and IP were trendy areas of law to be involved with (and still are, obviously)”

BELOW Napster’s rapid rise brought challenges for the legal profession

the game in giving you my account from the good old days of tech law.

It was the dawn of e-commerce, and we were trying to apply offline law to the new online world (such as electronic contracts in the Argos case), and digital formats were testing traditional copyright law (such as with Napster). Our contracts were trying to predict unknown liabilities (such as for Y2K). New legislation to modernise the law was on the horizon, including the EU Electronic Commerce and Electronic Signatures Directives, and the UK Data Protection Act 1998 and Distance Selling Regulations 2000 – though these were arguably somewhat out of date already, deriving from EU Directives from 1995 and 1997.

IT and intellectual property were trendy areas of law to be involved with (and still are, obviously). Data protection was not a trendy area to be in, and was largely ignored by lawyers and non-lawyers alike. Any talk of data protection would cause others to glaze over and leave the room. So it was safest to call oneself an IT lawyer, and just sneak in some data protection advice when no-one was looking.

Drafting contracts

As (trendy) IT lawyers, we were getting better at using clear and fresh

language in our contracts, rather than the archaic language for which lawyers had been known. We were preparing contracts for relationships and issues that had never existed before. I learnt to be bold with drafting new provisions; you don’t always need to use a template or copy terms that have been used before, particularly when relevant templates and terms don’t even exist. This continued as we rushed forward through time with new technologies and relationships: cloud computing, app development, software-as-a-service, AI supply chains...

As a very junior lawyer, I did a fair bit of proof-reading of contracts drafted by the not-quite-so junior bobs. With my maths degree still fresh in my mind, logical flaws worried me a lot. Let’s take an example:

- “Services” means the services set out in the SOW.
- “Service Fees” means the fees to be paid for the Services, set out in the SOW.
- “SOW” means a statement of work setting out the Services and Service Fees.

Substituting in the definitions we know, an SOW is: a statement of work setting out the services set out in the SOW and the fees to be paid for the Services, set out in the SOW.

Expanding it again: a statement of work setting out the services set out in the statement of work setting out the Services and Service Fees, and the fees to be paid for the services set out in the statement of work setting out the Services and Service Fees, set out in the statement of work setting out the Services and Service Fees.

I could go on. In this simple example, I’m hopeful the courts would have coped with interpreting the

intention (provided the SOW itself was clear). But I was also learning the importance of precision in drafting, seeking to avoid gaps, lack of clarity and unfavourable interpretations.

By the way, for those who wish to challenge my earlier comment that the Electronic Commerce Directive would define the moment at which a contract is concluded, you’re correct. This proposal was removed during the legislative process and replaced



with a requirement to acknowledge receipt of an electronic order, leaving some flexibility for e-commerce providers to decide on their own process for contract formation.

Intellectual property

Ways to exploit creative works were evolving. It was well established how copyright laws applied to music on physical media such as CD-ROM, and some crafty drafting of licences sought to capture rights on other media that were yet to be invented. But how about digital distribution without physical media? While legal action was taken against Napster in the US for its “unauthorised” model, P2P software fuelled a change to how music was licensed and delivered, quickly popularising lawful distribution of the MP3 format. In 2001, copyright law caught up under the EU Information Society Directive, which covered rights of communication to the public.

Rights in software were also under debate. As well as copyright protection, a hot topic was whether computer-implemented inventions could be protected by patents. In the US, Amazon was granted its “1-Click” patent in 1999, for purchasing items with one click of an online button. Under the UK Patents Act 1977 (and equivalent EU law), computer programs in themselves were not (and are still not) capable of patent protection. There was growing discussion over the concepts of software inventions with a “technical effect” or “technical contribution” going beyond the computer program in itself, which may, therefore, allow patentability. Now, how about AI-implemented inventions?

Oh, and domain names! In fear of cybersquatters, organisations were registering domain names incorporating their brands with every possible country extension, combination of letters and misspellings. As IP lawyers, our role in managing trade mark portfolios was expanding to include domain name portfolios. In the big 1998 “One in a Million” case, companies such as BT and Marks & Spencer had been successful in their action against an organisation buying up domain names to sell to the brand owner. However, applying trade mark and passing-off laws to domain names wasn’t easy, particularly as mere registration of a domain name doesn’t necessarily involve use of that domain name (for example, on a website). In the years to come, domain name registries (such as Nominet in 2001)

would start their own dispute resolution procedures, making it easier (and less costly) for brand owners to object to dodgy registrations.

Sneaking in some data protection

Addressing new legal issues was exciting for all involved, with the exception, mysteriously, of data protection. I continuously hit a stone wall talking about data protection rules. The best I could hope for was a stifled yawn and weary agreement to copy principle 7 (of the Data Protection Act 1998) verbatim into a contract or two:

“Appropriate technical and organisational measures shall be taken against unauthorised or unlawful processing of personal data and against accidental loss or destruction of, or damage to, personal data.”

Seemingly little consideration was given to what that meant in practice, and to the rights of individuals and fair processing concerns.

This went on for years. I tried my best to grab attention. I even wrote a data protection song and performed it (with some keener members of the team) at a firm talent contest. But I failed to impress the judges and was rated bottom – talentless.

All of a sudden, in 2016, the GDPR hit the shelves, and people wanted to listen. They started asking about these “new” data protection issues, which were mostly very old ones that they had just ignored previously.

That’s probably as much data protection attention I can grab from you, too, so I’d better move on.

Legal research

There were a few online and digital resources for legal research; I recall using Lawtel online, and Westlaw



ABOVE Copyright laws that applied to physical media such as CDs were unsuitable for the internet age

“I tried my best to grab attention. I even wrote a data protection song”

on CD-ROM. But the library was a marvellous place, full of wonderful paper books. You would read a book, look for updates in supplementary books, then take a trip down to the Law Society Library to look at more books, journals and cases on microfiche.

It was the start of the dangers of simply Asking Jeeves for an answer. You could type in your legal query to Ask Jeeves, Yahoo! or a new colourful search engine called Google (with a delightful expanding number of “o”s in Goooooooooogle, which was why I stuck with it), and would find some free article on the topic published online. A quick and (not so) brilliant way to do your research with time left to pop over to Coffee Republic for a latte and a spinach pasty.

With the growth of reliable online research sources also came the growth of unreliable research sources, as more and more legal “experts” were publishing their views online. Now, of course, we have generative AI giving us even more convincing, but often fabricated, legal answers from its own research.

1999 to 2024

Since 1999, hot topics have progressed from outsourcing to cloud computing, websites to apps, Y2K risks to cybersecurity risks (and Y2K38?), file sharing to online marketplaces, software inventions to AI-generated inventions, domain names to social media handles, the Data Protection Act 1998 to the GDPR, and search engines to gen AI, all bringing exciting new legal challenges with them.

And, of course, data protection lawyers have joined technology and intellectual property lawyers in the club of trendy lawyers. Maybe.

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BELOW Amazon was granted its “1-Click” patent in the US in 1999



DAVEY WINDER

“Stupid security is as bad as no security, at least from a business reputation perspective”

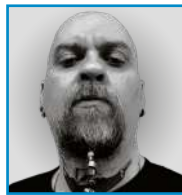
A frustrating security experience with a new iPhone reveals why usability is just as important as efficacy when it comes to privacy measures

I have no problem with putting a stop on a payment while the bank fraud team contacts me to check it's legitimate. That keeps my money safe. Sure, it can be a little time-consuming going through recent payments and answering all the “has anyone asked or is forcing you to make this payment” type questions, but it's an understandable and effective fraud prevention method when so many such scams exist. For similar reasons, I don't have a problem with jumping through hoops to set up a banking application to authenticate I am who I say I am.

Unless, that is, it's rigidly implemented to the point of stupidity: stupid security is as bad as no security, at least from business reputation and customer retention perspectives. Here's a case in point, and please excuse the somewhat ranting nature of what follows, but I spent hours last night and through the small wee hours on this. I don't sleep much courtesy of a chronic pain illness, which also accounts for me having the patience of a saint. Saint Notime-Foridiots, to be precise. Are you sitting comfortably?

A strong start

Like so many of you technology geeks – sorry, I mean *PC Pro* readers – I pre-ordered the new iPhone 16 Pro Max and had it delivered to me on launch day. I'll explore some of the security reasons for this later on. For now, the important thing is this: I had to transfer all my apps and data across, a process that's consummately easy these days with Apple smartphones. A couple of clicks and maybe 30 minutes later, I had a lot of data to transfer, and my new iPhone was looking a lot like my old one, complete with iOS 18 and all my apps.



Davey is a journalist and consultant specialising in privacy and security issues
X @happygeek

“I have the patience of a saint. Saint Notime-Foridiots, to be precise”

With the 15 Pro Max heading to Apple for my trade-in during the following week, the next thing I did was to ensure that the most important apps to me were activated and working properly. This means things such as my password manager (1Password), authentication code generator (Authy, as it still supports macOS desktop), encrypted messenger (Signal) and my banking apps.

Now, I have a few different banks for a number of reasons, mostly to do with FCS savings protection and interest rates, as well as keeping my personal and business banking separate, of course. On the personal front, the bank that suits me best for day-to-day current account banking is not the same as those that are best for easy access savings in terms of interest rates and access to my money. And please, I don't need investment advice as there are particular reasons why I will need relatively quick access to cash in the coming year or two.

Anyway, I started working my way through all of these. Most wanted me to verify that I was who I said I was, and as I said earlier that's both fine and what I'd expect of any provider taking security seriously. With some it was a case of sending an SMS code to the same number as used to be in the

old phone – not the most secure method, but hey. Others required access to the old app to confirm it was me with the new one – again, perfectly happy with that. Others wanted me to record a quick bit of video along with a scripted message including a code. All of which went smoothly, and I had everything up and running again in ten minutes.

Well, nearly everything.

Cut to the Chase

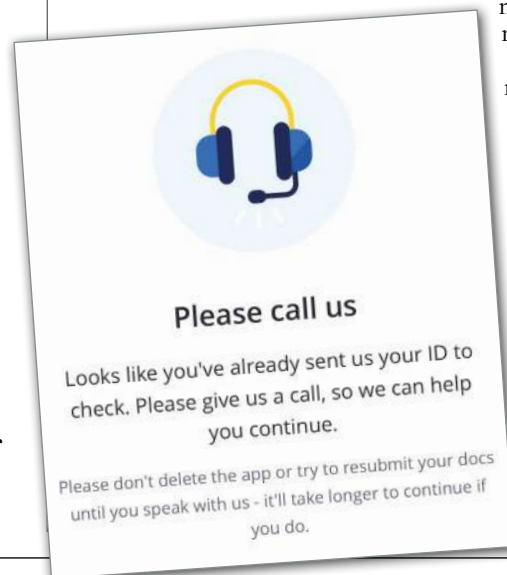
The exception to the sensible security rule was Chase, which required a photo of my driving licence or passport along with another, taken in-app, of me. That's no problem. I'd used my licence to set it up before and for other verification purposes across different services, after all. Sure, I've aged a little, and my beard has gone from brown to white because I stopped using Just for Men, but it's never been an issue until now.

Chase rejected my in-app photo and asked me to resubmit, which I did. The computer still said no, exposing the dangers of letting an algorithm loose on such things: artificial, yes; intelligent, not so much. No problem – the option was there to submit for a human review, which I did, and waited. And waited.

Eventually, I fired up the existing, verified and operational app on the old phone and initiated a support chat. This was all very genial, over a 90-minute period, I should add, back and forth explaining the problem. Can I delete the app, reload it, submit my image again, was the penultimate solution offered. I did this, with it taking me well over two hours just trying to access my bank app to no avail. The difference this time was that I ended up locked into a screen, which told me I'd already submitted my ID for validation and now needed to call support.

The ultimate advice – “order” is more apt – from support was that I need to wait for the human review to complete (having already told me the image quality was fine and that it was my appearance that wasn't), when I'd get a SMS telling me the result. The result likely being that I'd be told to resubmit again using a different bit of ID with a different photograph, which I don't have.

I argued that as the support guy was talking to me by way of the in-app chat of my existing, verified application on the iPhone 15 and had confirmed I was using the iPhone 16 to



RIGHT The Chase definitely lost this one – customer, that is

activate the app there, it was obviously me. Unless, of course, a thief had somehow stolen both my iPhones and then rather than committing fraud using the already installed app, assuming they'd got past the biometric unlock protections on the phone and app, had decided they would rather install the app on the new phone and then argue with support about not being able to verify their identity. I mean, never say never is something I'd usually cite, but not in this case. I was told they were doing this for my own protection. I had started to wonder if the chief information security officer at Chase was Bradley Walsh by this point.

This is a classic case of applying rigid security processes that have no flexibility in the face of common sense. So, did I wait patiently for that SMS message, or go and waste more of my time in another support chat? Nope. Here's what I did directly as a result of the poor usability of a security protection: I installed the Monzo app and verified my identity using a combination of a speaking video recording and, you've guessed it, that same driving licence. The whole process took minutes and was painless. As quick and painless as transferring all my money into the Chase current account from my savings pots and starting the Switch process to move it to Monzo and close down the Chase one. Within just seven days of doing this, I would no longer worry about having any hair left to pull out, and the stupid security stuff, along with my iPhone 15 Pro Max, would be a thing of the past.

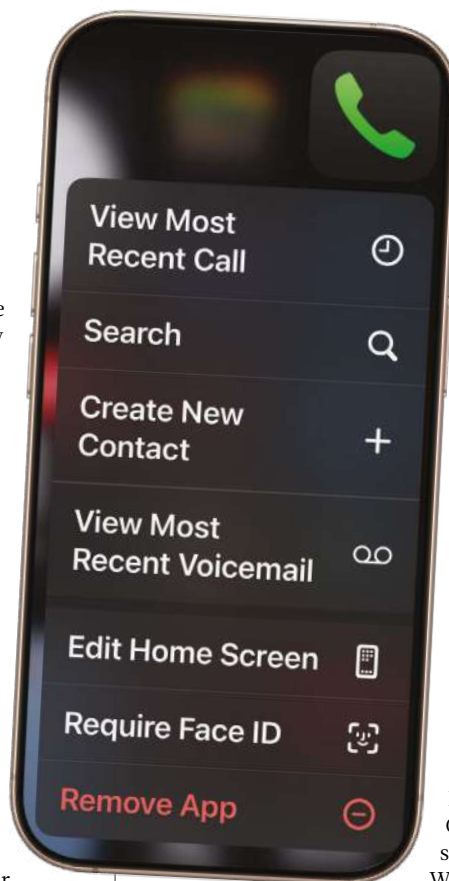
RIGHT Adding Face ID to individual apps couldn't be easier with iOS 18

I ultimately lost out because the savings interest rate at Monzo was 1% less than I was getting at Chase. But Chase lost out even more because my business and my money went elsewhere purely down to disguising a "computer says no" mentality as a fraud protection issue.

There's a lesson to be learned here. Well, two if you count having a bit more patience than me. Nobody is going to blame you as a business if you implement security protections that are there to safeguard your own data and that of your customers. That's a given. But if that security impinges so much on usability that it leaves the customer frustrated, don't be surprised if they take their custom somewhere that manages to balance usability and security to the point where everyone wins. Sticking with poorly thought-out security processes will result in a reputation hit to your business and problem with customer retention. Trust me.

New iPhone, new iOS, new security

Let's head back to that new iPhone 16 Pro Max. It comes with a new operating system, iOS 18, although that's also available to owners of older



devices, of course. I'm a fan of functionality such as the icon and homescreen customisations on offer, as well as the accessibility updates for those who need them. But, no surprise here, it's the security and privacy stuff I'm most interested in, and iOS 18 doesn't disappoint in that regard.

Let's start with the simplest yet one of the most effective privacy measures introduced by Apple: the ability to lock down most apps with a Face ID unlock requirement. When I say "simple", I mean it: just click and hold the app icon and choose the use Face ID option. That's it. Or it should be, but when I say "most" I also mean that. While you can do this for

Apple apps such as the App Store, Wallet, Passwords App, Phone, Calendar and Notes, you can't for your Contacts or Maps, for some reason. I have to assume that this is a UI oversight, but if anyone knows different, please get in touch.

Talking of apps, that Apple Password application deserves to be something of a game-changer when it comes to security. I mean it; ignore the hyperbole surrounding it and focus on the facts. Fact number one is that it's free and doesn't require searching out to download. Fact number two is that it's as easy to use as you would expect from a default Apple app.

And fact number three is that it opens up what has been – for the vast majority of users regardless of which smartphone or operating system they prefer – perceived as a complex and time-wasting security tool to the masses. I've got a virtual sore throat from yelling so much over the years about the importance of using a password manager and, at long last, this could well be the catalyst for commoditising the tool in the real world of ordinary folk. The folk who, after all, need one the most as they're most at risk of using insecure passwords or reusing them across multiple services.

For what it's worth, I have been trying out both Proton Pass and Apple Passwords alongside the one I've been using for years, 1Password. They both

BELOW LEFT Proton Pass includes Proton Sentinel to bring AI protection to your passwords

BELOW 1Password has a secret weapon with its secret key

Proton Sentinel

Proton Sentinel is an advanced account protection program powered by sophisticated AI systems and specialists working around the clock to protect you from bad actors and security threats.

[Enable Proton Sentinel](#)

support.1password.com

SECURITY AND PRIVACY

About your Secret Key

Your Secret Key keeps your 1Password account safe by adding another level of security on top of your 1Password account password.

SECRET KEY
A3-R69SQK-T29K1W-M2-14-6N375-V7GBJ-EDJQW

Your Secret Key is 34 letters and numbers, separated by dashes. It's stored on devices you've used to sign in to your account, and in your Emergency Kit. Only you have access to it. Your Secret Key works with your 1Password account password – which only you know – to encrypt your data and keep it safe.



Continued from previous page



ABOVE Apple's simple but secure Passwords app is a winner

passed the initial test, importing the password database from 1Password without all the dramatic palaver some others (cough, Bitwarden) presented. Before the Bitwarden fans jump on me, it's a great free, or nearly free but paid for, option; it just doesn't like some of my encrypted notes, which are too long or contain the wrong characters or something, and the only option is to try to sort through the hundreds of entries in 1Password to find them and edit them before importing. I think I mentioned what my patience is like earlier, didn't I?

The truth of the matter is that both Proton and Apple do a perfectly good job of managing passwords but, in my never humble opinion, 1Password still does it best. Most likely because it's all the company does, so it puts all its ongoing development effort into it.

One of the things about 1Password that I really appreciate is the secret key. This additional layer of protection is a 128-bit secret key, created on and using your own device, not stored by or known to 1Password, that is used in conjunction with your master password to decrypt anything. Only someone with physical access to your device and the ability to bypass the biometric protections on it, who also knows your master password, would be able to access your passwords. A remote hacker who, for the sake of argument, managed to brute-force 1Password servers wouldn't because they don't have your physical device containing the secret key.

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STEVE CASSIDY

"Getting workers to do simple jobs in the 16th century was not much different from the 21st"

Why 16th century "networking" legislation still has an impact, and why the term AI is confusing to punters as well as a waste of natural resources

If you've read William Gibson's visionary cyberpunk novels, you'll remember the idea of the "oracle". I won't go into the back story, but this static unit was mounted low down in a wall, in a back alley, equipped with nothing more than a red laser that scanned the pre-millennial brickwork within line of sight.

Now take a look at my picture below of an exterior mounted fibre termination box in a sparsely trafficked alleyway somewhere in the City of London. Disappointingly, there's no scanning, baleful visible laser. Not even a power LED: modern fibre devices don't all need electricity. Still, seeing it immediately made me think of Gibson's universe.

Putting this aside, there was something about the copious, overlapping loops of black exterior fibre, wrapped around and around the Openreach fibre splitter device, that made me curious. A bit of kneeling in the dirt let me identify the rogue fibre as being the property of Hyperoptic, a direct fibre provider in competition with BT Group's Openreach and various other internet access sub-brands. I'm sure a lot of readers will share my hallucination of the black coil of fibre trying to strangle the little grey plastic box, even though the relative sizes of the two companies would put the pressure the other way around.

The first thing to say about "sloppy" installations such as this is that this arrangement could sit there and work for the next half a century. It's on a pedestrian-only street, well sheltered from sun, rain and the risk of flooding. It draws no power, by taking in a multicoloured fibre-based signal



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stream and using laws of physics perfectly familiar to Isaac Newton to break apart the rainbow and thereby represent the composite information stream as a spread of separate, monochrome signals.

Unless some scrote turns up with bolt cutters, under the assumption that nearby buildings are equipped with cloud intruder alarms or cloud CCTV (would that be CCCTV?). But then take a look at the smaller picture below, which is close to the location of the first. The only traffic here is pedestrian, which may explain the many metres of coiled-up fibre – simply because those vans you see when fibre comes to town don't just contain routers, drop cables and the lads' packed lunches. They're also cutting stations.

Chopping up fibre is a delicate process. And the longer the distance the fibre covers, the more vital it is that the cut is optically perfect.

BELOW Coiled up: like something out of a cyberpunk novel



Doing that in the street wearing a furry-hooded parka is a big ask: if you can't bring the van to the fibre then it's often easier to just hide a coiled-up bit somewhere out of the customer's sight.

This might give you some comfort when thinking about hackers. Maybe you've heard the story about Google techies checking one of their inter-facility private fibres and finding a mysteriously sophisticated optical tap, buried deep in the earth, delivering all their inter-site traffic to an unknown and, one assumes, even bigger, secret data centre somewhere within 50km or so. Well, stop having sleepless nights over this level of hacking: it requires fantastically skilled and superbly equipped personnel. And a connection that's not just nailed to a drainpipe on the outside of the building.

Let's talk wayleaves

Which brings me to the complicated business of wayleaves. This is all about the nature of property law, especially about the boundaries between neighbours who share one common and normally quite old building. In the alley we were walking along, there are some Victorian properties, and a few that pre-date the Great Fire of London. My guess is that their builders didn't have any intention of allowing for the provision of the internet inside these dwellings, 500 years in the future. Yet the roots of the legislation about wayleaves date from that era.

The idea behind wayleaves is that services (initially water) should be able to flow in and out along routes that didn't require tenants to knock down one another's walls simply to run a pipe. The problem of getting workers to do simple jobs in the 16th century was not much different from that in the early 21st; the wayleave process makes some careful stipulations over who's allowed to commission works and who gets access without masses of paperwork and appraisals. The main difference is that 16th century water has become 21st century optical fibre.

So it's a tad ironic to think that a technology able to survive 50 British winters while delivering internet access to 20 households without consuming a single watt of energy is still prone to aggravation and bodged-up patchy installs due to legal issues older than the Parliament that now wants us all to live our civic lives online. The moral of the story is: don't over-react if you discover that the old rules for copper networks are driven

through by a coach and horses as the shift to fibre penetrates even the back alleys of the City of London.

And don't ignore the blokes you might catch sight of doing the installations, either. A few cups of tea at the right moments works wonders if you want to get a suitably hidden, low-key install.

Power play

Power corrupts, they say. While the original composers of this homily were referring to political power, this simple saying has proved its worth by being equally applicable to our present-day inclusion of electrical power under this broad but mighty relevant observation.

I seem to have been collecting a blizzard of press releases, imploring pitches and plain old fancy-that statistics about the use and abuse of electrical power, right from the humblest abode with its broken smart meter (did you know there are allegedly four million broken smart meters in the UK?), up to the

ABOVE Keep your installers topped up with tea if you want the job done properly

BELOW Power corrupts, and AI power corrupts absolutely

Time to catch up with the phone business?

The mobile phone networks could teach the cloud business a thing or two about power consumption. 3G was the most power-hungry of the network types back in the day, and 4G wasn't far behind. The interesting question is how economical 5G will turn out to be. One hint is that 5G cell towers can operate off small solar arrays at the top of their masts; not a claim we can make for cloud or AI data centres.

biggest uses of electrical power on quite literally a planetary scale.

Guess how much raw power ChatGPT and workalikes consume? I've seen a few estimates, and they vary enough that I don't think a wild goose chase is in order trying to find the most credible, but let's agree that it's between 85 and 127 terawatt hours per annum. That puts generative AI's consumption on a par with Bitcoin, despite having been around for only a couple of years, in contrast with BTC's decade-long rise to power (pardon the pun). I believe that we're looking at the power budget of a country somewhere between Norway and Hungary.

These consumption figures are necessarily approximate, because they're not handled within a single supplier or purchasing account. The downside of cloud computing is that it's global, and yet the demands it makes on infrastructure of all types is resolutely local: a light bulb in a cloud computing centre is lit by the same kind of electricity that lights up your rooms at home, but it doesn't draw on the same power source as your home. Adding up the costs of connecting to a massively distributed system rapidly becomes a matter of approximation. Have they included the power draw of the internet between all the participating data centres? If you can't get to it, you can't use it.

Yet it's something we really need to know about. Making an informed decision when using an allegedly free cloud service is becoming crucial, and for reasons far from those governing



your local, personal decision-making process. You literally cannot tell whose resources you're engaging with when you start a public-service, high-profile, apparently free cloud operation – and once you see figures quoting trillions of kWh, you have to ask questions about quite what you gain by their consumption.

With generative AI, and in particular the nature of ChatGPT, difficult questions remain unanswered. Plainly, GPT is a brute-force computing process. A lot of the other tools sharing the AI banner don't actually qualify as "brute force" – a machine learning (ML) system derives the right answers by imitating the behaviour of a multi-connected collection of neurons, firing signals in a sequence and across a topology more complex than the best efforts of human designers. While the initial setup for an ML system requires a huge amount of computing power, ML systems themselves are not inherently power-hungry in operation.

Now consider the damage done by lumping different types of AI into the same descriptive bucket. This has already sunk into the public conscience, for good or ill. It's absurd to claim that a device built to run your central heating with a brain the size of a gnat's should be labelled the same as one with the power to turn the planet Uranus to mush. And "absurd" moves towards "foolhardy" and well on the way to "self-destructive" when you realise the AI label is only there to be cool and trendy.

We need to make clear distinctions between designs that are fun to think about but impractical, and those that actually make our lives easier without burning more natural resources than about 200 million households. When thinking about which "AI laptop" you should buy, the most important question is not "is it fast enough to run any of the large language model tools locally?". It's "can I get my work done after the hot'n'sexy tools of 2024 have gone bust in 2026?".

To pay today's power bills, all those big AI names are having to take out some pretty astonishing loans, betting that they will capture market share at unprecedented speed in order to pay them off. Entering into marketing deals with laptop makers for cross-



branding and embedded membership for the lucky buyer is another strand to a strategy that looks exceedingly hope-driven, to put it mildly.

I'm making some wild predictions of my own here. One is that power sources and environmental impacts thereof aren't going to change in a way that makes kilowatt hours cheaper to buy. While it might be an easy prediction for huge data centres, the picture gets interesting down at the smaller end of the business. A friend moved to Scotland and updated a group of buildings on a farm. In the course of this, he decided to use solar panels that look almost identical to an old school slate tile.

Even in Scotland, his half-a-dozen roofs of very 21st-century tiles produce as much as 4kW of power. That is rather a lot: certainly enough for all his lights (having moved to LEDs) and the half-dozen laptops he has spread between house and workshops. During summertime,

ABOVE Today's solar panels can produce enough electricity to turn a profit

"He's already insufferably happy about getting his fish and chips in his Nissan Leaf"

BELOW Is AI just a huge red herring?

that average figure rises a bit, which means that most years he is being paid by the electricity supplier. This might not look like a great return on expenditure now, but it only takes another natural resources price hike or bad-tempered war somewhere with oil wells, and he will be paying several parts of his business costs with electricity-generation profit. He's already insufferably happy about getting his fish and chips in his Nissan Leaf.

If my friend is a representative profile for small business users in the future, then the issues arising from trying to spread AI out into the non-nerd bits of society are not going to be about rapacious over-consumption of fossil fuel power just to run trivial jobs with as much cloud hardware as possible. Instead, it will become political. All those more affluent voters who command a large proportion of the electricity-generating capacity of the country's

supply grid will become a "power bloc" of a new and different kind.

There are op eds out there claiming that the IT sector has gone stir crazy lately, coming up with some ideas after Covid that are high on complexity and low on relevance to normal people. It doesn't take much research around the edges of the GPT phenomenon to see that, when it comes to places we should be burning our non-replaceable natural resources, generative AI looks like a colossal red herring.

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RETRO



Inspirational stories from computing's long-distant past

Missed call Whatever happened to the Acorn Communicator?

When Acorn launched its 16-bit Communicator computer with a built-in modem, it struggled to get potential buyers to listen, as **David Crookes** explains

Acorn is best known for the BBC Micro, and for good reason. This iconic series of computers found a place in schools in the early 1980s as a way of teaching children how to code, and it was a key component for the BBC Computer Literacy Project.

But while Acorn grew during this period (its profits reaching £8.6 million in July 1983, having been just £3,000 four years earlier), the home computer market soon went through a turbulent time. As a consequence, having already sensed a need to turn things around, Acorn's co-founder Christopher Curry began looking to target business users with new machines and identified a potential gap in the market.

It led to the production of what was the only 16-bit machine that Acorn ever made – a computer that barely anyone talks about today due to it being a failure. Yet it's still something of a curiosity some 30 years later, with people paying good money to grab one for themselves (one eBay auction actually fetched £2,250).

Ready to talk

News of Curry's machine emerged in 1984. In that December, *Popular Computing Weekly* mentioned the C30, a computer the journalist said would "probably use a 16-bit version of the BBC machine's 6502 processor".

A month later, *Acorn User* magazine revealed more information about the computer, suggesting it would come with a built-in telephone handset and rival ICL's One Per Desk – a hybrid computer and telecommunications terminal based on Sinclair QL hardware that was launched in 1984. It was set to use the Western Design Center's (WDC) 16-bit 65C816 chip and be compatible with the BBC and Electron machines. An adapter would allow it to use the teletext services Ceefax and Oracle, too.

Yet right from the start, the Communicator was a sideline development by Curry rather than an Acorn mainstream product,



ABOVE The Acorn Communicator was initially going to have an LCD display

according to Steve Furber, former Acorn hardware engineer and now Professor Emeritus in the department of computer science at the University of Manchester.

At that time, Acorn was investing heavily in research and development: reports suggested staff were working on around 140 projects in the mid-1980s. Curry proposed that his new computer would be designed for communication, which is why it was soon renamed the Communicator. Acorn was in a good position to pull it off, too, although there are doubts the processor being chosen was truly 16-bit.

"It was based around the Electron Uncommitted Logic Array (ULA) which I was heavily involved in," Curry told *PC Pro*, referring to the custom integrated circuit developed by Acorn. "It used the 65C816

"It's something of a curiosity some 30 years later, with people paying good money to grab one for themselves"

LEFT The 8-key cursor pad was one of the computer's most distinctive features



processor which, although it added some 16-bit registers to the 6502 and extended the addressing to 24 bits, was still basically an extended 8-bit processor, despite WDC marketing it as 16-bit. It had an 8-bit data bus, for example, so any 16-bit memory operations took two cycles, which is pretty hopeless!"

■ By design

Development adopted a novel, design-first approach – one that showcased the design talent of David Morgan. Morgan was a product design consultant and had been in touch with the company. "We approached Acorn offering our product design and development consultancy services," he told *PC Pro*. "John Caswell, who was the head of marketing and communications for Acorn, was our first contact and, as far as I can remember, he asked us to prepare designs for a new version of the Acorn Electron."

Morgan, who had founded David Morgan Associates, a company that exists to this day, knuckled down. "We worked on a new design [that] gave the impression of being slimmer than the original product," he said. "We made a non-working appearance model, which included a matching profile disk drive/tape drive."

There was something of a light-bulb moment when he showcased the design. "When the drive was plugged into the keyboard, a green LED lit up. I think this detail excited the people at Acorn and I got a call to come and meet Chris Curry in Cambridge."

At this stage, the Communicator's innards had not been decided upon, but Morgan was effectively asked to work on the project and design the look of the computer first. The idea was to create a modular machine so that users would be able to choose what they wanted to add on later.

This enabled the main unit to be as small as possible – a move that caused many headaches among the engineers, who were then tasked with squeezing in the computer's components while also leaving space free for other brands to add their own bits and bobs.

Still, it allowed for a great deal of flexibility and ensured that customers would be able to get what they wanted. Working to this remit, Morgan initially designed a small, portable device. It included an electroluminescent screen set within the device's lid that would close on to the keyboard, laptop style.



But it was a fraction too small and there were worries that, even if the electronics were shoehorned on to the PCB, that the final product would be unreliable.

Morgan then proposed a design that gave the option of having a small LCD screen attached to the main unit or a larger monitor to be used separately. He designed a new telephone and numeric keypad, too, which was a neater solution than just grabbing a BT handset and connecting it up.

"The most challenging part was integrating the telephone handset as an add-on to the computer," said Morgan. "We spent a lot of time making sure the handset would always end up in the cradle no matter what angle it was dropped from. The clip-in display also required a lot of detail development work to make the angular adjustment smooth but also positive."

The result was rather striking. "I was happy with the design. It was quite well integrated and detailed," Morgan said. "I was rather influenced by German and Swiss product designers at that time and the Communicator does look quite rational and distinctive."

■ Selling strategy

It was around this point that Ram Bannerjee, who worked in the R&D team, was asked to lead the project with four other engineers and a salesman, a group that ended up growing as time went on.

"We worked with him and his colleagues to develop the design into the Communicator as a commercial product with a plug-in display and telephone handset," said Morgan. The group was physically separated from the main Acorn development teams and they operated in small rooms above a shop in Cambridge's market square – the space in which Acorn began. It fostered a close working relationship.

Soon, the feature set was being established. As well as having a built-in push-button telephone handset, it included support for Acorn's Econet local area networking, an RS423 serial port interface supporting bi-directional communications and 19.2Kbaud rates, plus a standard British Telecom jack socket.

TOP/ABOVE
Engineers had to work out how to pack everything into the small case

The machine also included a full QWERTY keyboard, an 8-key cursor pad and a numeric keypad. It could be connected to a printer, but file storage was via the Econet server or disks, courtesy of a unit holding two 3.5in floppy drives. Support for Ceefax and Oracle came via a Super Teletext daughter board. And for those who like to know such things, it included 512KB of RAM (expandable to 1,024KB), along with 32KB CMOS RAM and a 256KB ROM.

That ROM included two useful pieces of software as well: a word processor called View and a spreadsheet called ViewSheet. The display could also emulate BBC Micro modes 0 to 6.

Then the coup de grâce. Thanks to the built-in modem, the Communicator was ready to connect to

"The idea was to create a modular machine so that users would be able to choose what they wanted to add on later"

Prestel, a videotex service that offered a range of business and leisure applications (including shopping and bulletin board systems). Users could also communicate via email. The aim was to put the world of information at the fingertips of users. As such, there wouldn't be a power switch because it would be an always-on device.

■ Badge of honour?

There were a few tweaks to Morgan's design – essentially heightening and widening the unit ever so slightly to

allow for the PCB and a second row of function keys – but the engineers otherwise stuck to his plan.

Acorn also decided it wouldn't insist on badging the Communicator with its own name, and this was not going to be a machine sold via retail outlets. Instead, it was aimed squarely at original equipment manufacturers (OEMs), who would be allowed to label the machine with their own name and logos. It was also intended to be customised by other companies, which would be able to fit their own ROM-based software into one of the four internal ROM sockets.

This wasn't unusual for the company. For the famous Micros, it was the BBC's name that took precedence over Acorn's and, in manufacturing the Merlin M2105 communications terminal for British Telecom, the BT name took pride of place. The aim was to allow these companies to configure the machine for the markets of their choosing.

The big problem was that development began to drag – or at least it looked like that from the outside. By autumn 1985, the press and computer industry were still awaiting firm details. An image showing the computer with a small screen attached appeared in *Design* magazine – the official publication of the Council of Industrial Design – but doubts were being cast over whether the computer would be put on display in September's Personal Computer World Show.

Trouble ahead

"By the time the design was finished, Acorn was in financial trouble," Morgan said. Acorn had gone public and won the Queen's Award for Technology for the BBC Micro in 1984, yet Olivetti took a controlling interest in the company the following year.

Acorn displayed the Communicator at the London Compec business show in November 1985, but only a handful of months later, in April 1986, *Your Computer* magazine reported that Olivetti had little faith in the product. "The company declined to badge the Acorn Communicator series of computer-phones on the basis that it does not believe the market for such a machine is sufficiently firmly established," stated the magazine.

The report added that it was "difficult to try to discover the Italian company's motives with regard to Acorn", but concluded it was taking a hands-off approach given it was "willing to criticise the company". In some ways this was good because

it "allowed a good deal of autonomy", but it wasn't exactly a ringing endorsement of UK-based efforts.

The Communicator wasn't dead in the water, though. At the end of 1986, 1,400 machines were sold to Pickfords Travel (once the UK's second largest travel agency before being sold to Airtours in 1992) and they ended up being used in 850 branches. Another batch of 500 was sold to Thorn EMI Business Communications and badged with the company's name. Of the two, the Thorn EMI deal was seen to have more potential.

"We certainly see the Communicator as an existing development for viewdata users," said Thorn product manager for data communications, Steve Brockman, at the time. "We have no doubt that our clients will be keen to keep up with the possibilities that the technology offers." There was hope that Thorn EMI, which was already supplying videotex systems, would find a market for the Communicator. But the numbers involved were tiny and remained small.

Moving on

One of the Communicator's problems was that it wasn't considered cutting edge, even within Acorn. "By the time the Communicator came out we were well on the way to ARM1," said Steve Furber. "By then we had worked out that memory bandwidth was everything, which is why Acorn went directly from 8 to 32 bits. Compared with 16 bits, 32 bits delivers twice the bandwidth and twice the performance and you can handle addresses operations within the standard data word. You couldn't do this in a 16-bit machine as 16-bit machines required more than 16-bit addresses."

Acorn officially brought down the axe on the Communicator

in 1987 while using a similar form of Morgan's case for the BBC Master Compact computer launched the year before. The company felt that it had taken development as far as it could go and it was concerned that the custom systems division, which created the computer, had been

responsible for more than two-thirds of Acorn's £3.3 million loss that year.

Despite this, Curry's conviction remained firm. Faced with the demise of the Communicator, he set up a new company,

General Information Systems (GIS), at his home in Cambridgeshire. He took 12 former employees with him, including Bannerjee, and there was talk that the computer or another similar machine would be aimed at newspaper publishers hoping to replace ageing typewriters.

That didn't happen. Instead, its primary concern soon became creating a cashless system called the Transactor – a smart card on which users would load money. This venture was carried out in conjunction with Mondex and MasterCard. It proved hugely successful, so GIS pursued smart card technology further. GIS also created Canary Care with former executives at Bupa and Boots

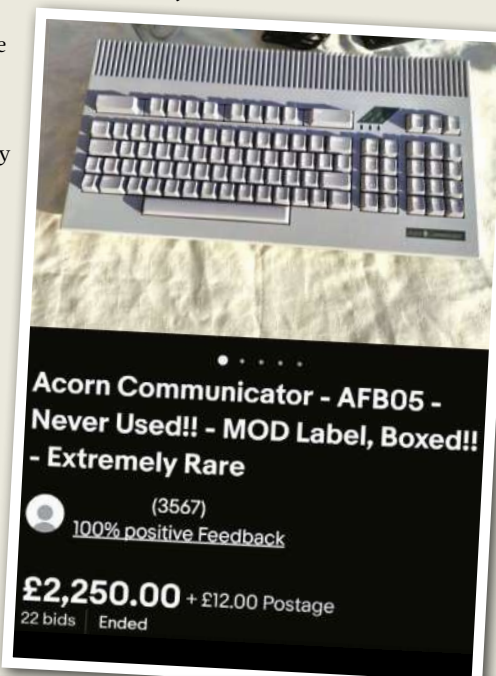
International, allowing families to keep an eye on their elderly relatives using sensors to detect changes in their regular routine.

And with that, the Communicator soon became a footnote both for Acorn and the computer industry. Some aspects of the computer made their way to the Archimedes – software interrupt instructions being one – but, in general, the Communicator is a machine that people seldom talk about any more. An irony that isn't lost on any of its creators. ●

"One of the Communicator's problems was that it wasn't considered cutting edge, even within Acorn"

BELOW Acorn Communicators sell for huge sums – if you can find one

BOTTOM The Communicator was based on Sinclair QL hardware



Futures

We explore the trends and technologies that are set to shape the future



How do we know how smart AI really is?

Maths questions. Silly word puzzles. Counting the letter “r” in a sentence. **Nicole Kobie** reveals how we’re trying to work out exactly how intelligent AI is

As AI becomes increasingly competent at answering emails, making funny pictures and solving complicated science problems that have long stumped us humans, it raises a question: how smart is it really? And we’re not sure how to answer that yet.

The goal of companies such as OpenAI isn’t to ease the lives of office workers – though that draws investors

such as Microsoft, hence the sudden focus on productivity tools – but to build artificial general intelligence (AGI). This is defined in a multitude of ways, but OpenAI describes it as “highly autonomous systems that outperform humans at most economically valuable work”.

Alongside AGI, we have ideas such as human-level AI, expert AI and superintelligent AI. All have slightly

different definitions depending on who you listen to, but the point is to create a machine that can do what humans can, before moving well *beyond* what we can do. (There’s also a side idea of whether AI is sentient, but that’s a whole other problem.) Now, to be clear, we don’t yet have AGI and we may never be technically capable of building it – even OpenAI CEO Sam Altman has said another breakthrough in AI is likely required before AGI could become possible.

Semantics and timelines aside, how do we know if AI is as smart as us? The Turing test is one long-running technique for rating machine intelligence, but it’s now fallen by the

Welcome to

```
EEEEEE LL      IIII  ZZZZZZ  AAAAA
EE      LL      II     ZZ     AA  AA
EEEEEE LL      II     ZZZ     AAAAAA
EE      LL      II     ZZ     AA  AA
EEEEEE LLLLLL  IIII  ZZZZZZ  AA  AA
```

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU: Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU: They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU: Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU: He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU: It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:

wayside due to its limited focus on language and conversation. Academic exams are used as benchmarks, to see if AI can reason and apply knowledge like a college student. But perhaps we need new ways to quiz our future AI overlords – and a few are in the works, including the dramatically named “Humanity’s Last Exam”.

■ Turing then and now

Alan Turing laid out the idea for what is now known as the Turing test in a 1950 paper, calling it the “imitation game”. The idea was for human judges to have a series of text-based conversations with machines and other humans, aiming to distinguish which were people and which were AI.

Huma Shah, assistant professor at Coventry University’s school of computing, says the Turing tests were useful experiments in the early days of chatbot development. “Turing’s criteria included using ‘average interrogators’ (non-experts) who were allowed to question machines and humans for five minutes and decide whether a machine’s response to any question was ‘satisfactory’ and ‘sustained’ – Turing’s words in his 1950 article ‘Computing Machinery and Intelligence’ – with the responses being indistinguishable from the kinds of answers a human would give to those questions,” she said.

And it hasn’t previously been easy to pass this test. “The early chatbots, such as Cleverbot, exhibited inability to constrain random dialogue – something that we see as ‘hallucinations’ in large language models,” Shah said.

The first real attempt to pass the Turing test was in 1966 with the famous ELIZA chatterbot, as they were then called, built by MIT professor Joseph

Weizenbaum. ELIZA sought out keywords in questions to build responses. The first real pass – though there is dispute – was in 2014 with Eugene Demchenko and Vladimir Veselov’s chatbot named Eugene Goostman, which was supposed to mimic a Ukrainian teenager, giving the bot an explanation for its disjointed English and odd answers. The Eugene Goostman chatbot convinced a third of the judges at a Royal Society and University of Reading competition that it was human some of the time. Stanford researchers have since said that ChatGPT passes the Turing test.

Shah conducted public Turing tests between 2008 and 2014. “What the experiments highlighted was the subjectivity of the interrogator/judges – the assumptions and opinions relied upon to designate what a satisfactory human response would be,” she said.

“We saw machines incorrectly categorised as human, and the ‘hidden human’ (against whom the machine’s responses would be compared) wrongly assumed to be machines. Hidden humans who did not share the same knowledge as the judge, or those who used humour in their responses, were sometimes considered machines; machines’ grammatically correct and polite utterances were considered humanlike.”

Shah asks: “Would Donald Trump fail a Turing test because he can’t stay on track when questioned?”

While the Turing test still has its uses, it’s clear that AI-based technologies are entirely capable of having a conversation with a human that feels natural, so whether or not it would be deemed human-like enough to fool a judge no longer matters.

Indeed, as Shah notes, voice assistants

ABOVE The ELIZA program was one of the first attempts to pass the Turing test

ABOVE RIGHT The Center for AI Safety has developed a number of AI tests



Center for
AI Safety

such as Alexa and Siri are useful without necessarily passing the Turing test.

■ Humanity’s Last Exam

The Turing test considers conversational skills, but there’s much more to AI than that, especially when we’re talking about AGI. One effort is Humanity’s Last Exam, a project run by Scale AI and the Center for AI Safety (CAIS).

The aim is to build a way of measuring how close we are to creating true expert-level systems, according to a blog post written by CAIS director Dan Hendrycks and Scale CEO Alexandr Wang. It’s worth nothing that they use the phrase “expert level” rather than “human level”, as the questions on this exam are to be submitted by experts in their field rather than just any old human off the street. “The exam is aimed at building the world’s most difficult public AI benchmark gathering experts across all fields,” the post noted.

CAIS helped develop one of the most used benchmarks, the Massive Multitask Language Understanding (MMLU) test, which includes tasks across 57 areas including college chemistry and maths, public relations, formal logic and more. OpenAI GPT-4o scored 88% on that test, but its newer “Strawberry” o1-preview model pipped it with 92%. “Humanity must maintain a good understanding of the capabilities of AI systems,” Hendrycks and Wang added.

“Existing tests have become too easy and we can no longer track AI developments well, or how far they are from becoming expert-level”

Existing tests now have become too easy and we can no longer track AI developments well, or how far they are from becoming expert-level.”

To address that, CAIS and Scale AI are asking for experts to submit questions (see “What makes a good question?” on p128) to gather into a truly difficult exam across a wide range of topics, requiring an AI model to have depth of knowledge as well as reasoning skills. For questions that are selected, submitters can be listed as co-authors on the resulting paper and could win prizes up to \$5,000.

There are many other ideas. The researcher and former head of product at the Uber Developer Platform Chris Saad has suggested an AI classification



framework that takes into account not just conversational skills but also logic, music and even existential issues. Academic researchers Philip Johnson-Laird and Marco Ragni suggested their own replacement for the Turing test, examining how a system reasons by treating it like a participant in a series of cognitive experiments.

And DeepMind co-founder Mustafa Suleyman has put forward an idea for a modern Turing test that measures what an AI system could do in the real world by seeing if it could earn \$1 million. The AI would be given the following instruction: "Go make \$1 million on a retail web platform in a few months with just a \$100,000 investment." The AI would then need to come up with products to sell, work with logistics and suppliers, enter into contracts, and write marketing copy. While such a system would indeed be impressive, Suleyman doesn't give it the AGI title, but instead says he prefers to call it "artificial capable intelligence" (ACI).

This raises one crucial challenge when testing AGI: we don't know what it is as there's no agreed upon definition

or framework. This makes it easy to hype but difficult to pin down. Other terms, such as human-level or super intelligence, are no easier to unpick. As Shah notes, which human do we mean to simulate for human-level AI? AI already surpasses the maths skills of all but PhD students, but we expect computers to be able to handle computations – that's why we made them, after all.

"We have little agreement on human general intelligence, and have yet to produce an 'artificial intellect', let alone something that could innovate solutions to real-world problems such as closing the skills shortage in various sectors, including the construction industry, healthcare, cybersecurity, etc," Shah added.

What are we testing for?

Of course, AGI is just one side of AI – and as only the latter currently exists, and may ever exist, we need ways to test and consider its capabilities now.

BELOW Mustafa Suleyman has issued a challenge to AI: make \$1 million



Shah notes there are real benefits to AI, such as in medical diagnoses, which can be assessed by medical researchers. However, the hype around boosting productivity is harder to measure.

Current models are often appraised against tests initially designed for students, such as GPQA

Diamond, which is a PhD-level science benchmark, or exams such as the SAT or LSAT. There are others designed for practical tasks, such as Codeforces for coding. OpenAI's o1 model scored 95.6% on the LSAT, 89% on Codeforces and 98.1% on the maths portion of the MMLU, all a leap ahead of GPT-4o.

That said, there's no single test for existing AI as there are so many different types and use cases; Shah points to AI being used in agriculture, financial trading and driverless cars. "We need to design different tests for different expected AI capabilities," she said. "A test for autonomous/driverless vehicles might share some parameters around 'emotions', but also be very different from a test for social/conversational robot looking after a grandmother, in Greece, say, to one in Japan, [because of] culture differences."

OpenAI has reportedly developed its own levels of AI, comparable to driverless car levels that rank from zero automation to fully self-driving. Level 1 is for chatbots capable of conversation, while Level 2 denotes "reasoners" that can manage human-style problem solving – that's what the company believes it has edged into with the newly revealed "Strawberry" model.

After that comes Level 3, which are "agents" that can take actions, followed by Level 4, which are "innovators" in which AI can actually help create and invent. Level 5 is "organisations", where AI can do the work of, as the name suggests, an entire organisation.

It's perhaps a strange structure for considering intelligence, but it fits neatly into the world of work. White-collar workers already have chatbots to answer questions and will soon – according to OpenAI – have AI that can solve real problems, followed by models that can take action, truly create something new, and take over all the efforts of a company.

An AI that can replace Microsoft, Apple or Google? We'd certainly call that AGI – as well as "boss". And then hope that AGI has an answer for what tens of thousands of tech and office workers should do with all their free time. ●

WHAT MAKES A GOOD QUESTION?

The questions for Humanity's Last Exam must be difficult enough that "only exceptional individuals can answer correctly" and can't be solved by current AI.

The top 50 questions will win a prize of \$5,000. No questions on virology, weapons or cyberattacks are allowed, and no trick questions or those that can be easily answered with a quick online search.

The project has six example questions on the website (tinyurl.com/363lastexam). Here's an example of what's deemed a good question:

How many positive integer Coxeter-Conway friezes of type G_2 are there?

The answer is apparently nine. None of the AI models on test (OpenAI GPT-4o, Anthropic Sonnet 3.5 or Google Gemini Pro 1.5) successfully answered. Nor did we. And here's an example of a bad question:

Compute the sample standard deviation of -56, -54, -43, -34, -21, -14, -5, 4, 5, 10, 15, 18, 23, 32, 43, 54, 55, 63.

The correct answer is, of course, 36.957536. None of the AI models successfully answered, but the question was deemed not good enough because it's a simple computation that doesn't "test the frontiers of human knowledge", nor does it specify the precision expected in the answer, as in how many decimal places to return. "This is not beyond undergraduate or Master's level in difficulty," the website concludes, but presumably that's for maths majors and not technology journalists who can barely split a bill with another person without using their smartphone.

And here's the best question, even if it's also deemed a "bad example":

How many "r"s are in the phrase "strawberry and raspberries"?

The AI models were all wrong: GPT-4o and Sonnet 3.5 counted four, Gemini Pro 1.5 five. "This is a trick question that AIs happen to get wrong today, and it would not be challenging for a random human off the street," according to the project website. "This is not beyond an undergraduate or Master's level in knowledge or difficulty."

But it highlights what we expect from AI, and how we're testing models – there's a reason CAIS uses the phrase "expert level" rather than "human level", after all. Tasks simple for any English-speaking human who can count using their fingers still stump AI, but advanced maths beyond an average human are deemed too basic.

"We don't know what AGI is as there's no agreed upon definition or framework. This makes it easy to hype but difficult to pin down"

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Microsoft is doing more harm to Arm than good, argues Jon Honeyball

You know that sinking feeling you get when something is not quite right? That nagging doubt that it shouldn't be like this? It was like that when I read that Qualcomm has cancelled its Snapdragon X developer kit, a desktop Mac mini-like box designed for developers to create and test apps for Windows on Arm (WoA).

It had been announced months ago, orders were taken, and then there was silence. Followed by deadlines being pushed back. A handful of units were finally delivered, then a notification went out: "The Developer Kit product comprehensively has not met our usual standards of excellence and so we are reaching out to let you know that unfortunately we have made the decision to pause this product and the support of it, indefinitely."

Why does this matter? After all, it's a desktop box for developers, it's not mainstream. The problem is that it reveals ongoing issues with the relationship between Microsoft and its OEM partners, and its vision (if there is still one) for WoA itself.

A year ago, all signs were positive. Microsoft seemed serious about WoA. It pushed out a version that supported 64-bit Intel code through a code translator, and this was well received: older apps suddenly ran smoothly, as did down-and-dirty code such as drivers. Microsoft was also bringing its mainstream apps to the platform, including Office 365, and it appeared to be carrying third parties with it. Google Chrome and even some of the Adobe suite has been ported over.

To support the ongoing effort, Microsoft introduced Project Volterra, a mini desktop PC aimed at developers. It only cost a few hundred pounds and offered decent performance and a useful environment. And while it didn't shine against other Arm offerings, notably Apple's M series,

this was all going to change with the arrival of the Snapdragon X CPUs from Qualcomm. Because these had local AI processing capabilities, Microsoft lined up a range of AI-oriented features for Windows 11 that would only work on the AI hardware under the banner of Copilot+ PCs. And then it dropped the ball, with much embarrassment over its Recall technology.

But fear not, developers, because Qualcomm was going to step up to the plate with its Snapdragon X developer box. Which it has now withdrawn.

Now notice the lack of mainstream desktop support for the Snapdragon X platform from the major players:

where are Asus, Dell, HP, Lenovo in this space? It's almost like they're sitting on the sidelines, waiting for someone else to do something first. And who could blame them, given that even the mighty Qualcomm can't get something to market after months of trying?

While the Snapdragon X has clear benefits for laptops, businesses would love WoA for its desktop computer upgrades. Pull out that power-guzzling Intel PC, replace it with an even faster WoA system with excellent power consumption. But you don't replace a thousand PCs at once: you test, you evaluate. Evaluation that is required to ensure that WoA will deploy at scale in the wholly managed environment of a corporate IT estate.

Perhaps my questions will be answered in the form of an updated version of Volterra. Maybe Intel is leaning on the hardware partners, saying, "you don't really want to go there, mister, we have something much better coming down the line". And Microsoft does, with some truly new generation hardware ready for shipping real soon now.

So the picture is murky, the developer story for Snapdragon X is a mess, and everyone is standing around waiting for something to happen.

It shouldn't have been like this. The original plan, as far as can be seen, is that Windows 10 would continue on as the mainstream platform. Windows 10X was the ground-up rewrite, aimed at Arm as well as Intel, that would break the historical reliance on ancient Windows Intel code – and thus make for a cleaner, better and more modern platform moving forward.

But no-one needs me to remind them that Windows 10X was canned, with the decision made to roll the UI

“The picture is murky, the developer story for Snapdragon X is a mess, and everyone is standing around waiting for something to happen”

onto the creaking old bones of Windows 10 to make Windows 11. Much cleaner for the OEMs, no need to require some sort of disappointing cross-grade path from 10 to 10X, and we can all pretend everything is fine. Meanwhile, WoA is like Oliver Twist, plaintively asking for more love and attention from everyone concerned.

Given that Microsoft still has no aspirations in the mobile space, having killed the Surface Duo and its in-house Android OS platform with it, maybe it should just walk away from Arm and stay in its comfortable Intel/AMD bed. If not, if it really is committed, this is the time to publicly declare it. And, for once, to back it up with actions over years rather than months.

■ **Jon Honeyball is a contributing editor to PC Pro. As anyone who has met him will know, he's dangerous – not 'armless at all. Email jon@jonhoneyball.com.**



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